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for the drilling-producing-pipe line industry

PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

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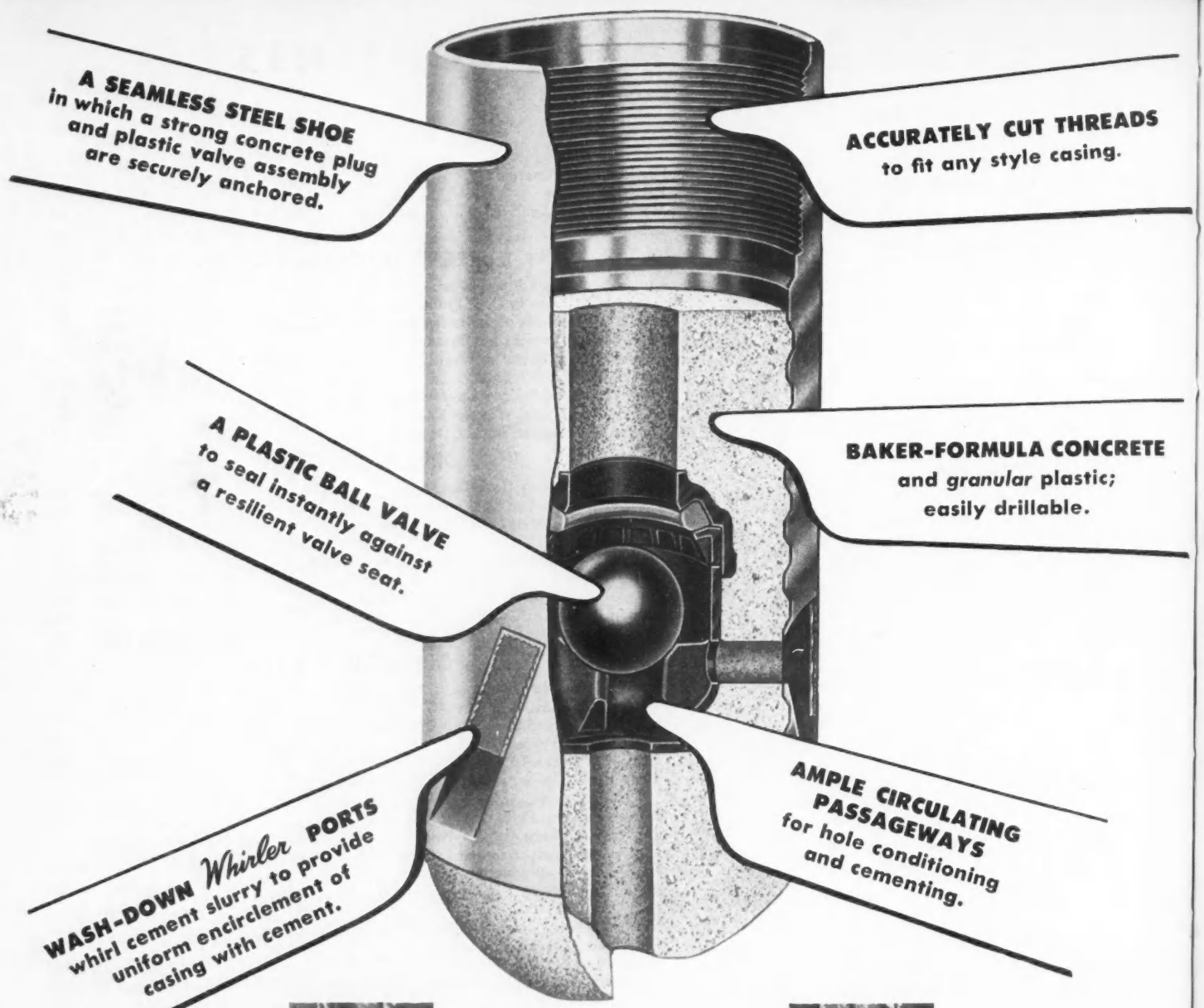
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The Changing Panorama

Oil Concerns Among Billion Dollar Firms

THERE ARE NOW almost 50 United States companies with assets in excess of 1 billion dollars each, and among them are four oil companies. The billion dollar concerns are predominantly banks and insurance companies. They include half a dozen railroads, the Bell telephone system (No. 1 corporation with assets of nearly $9 billion), and several other industrial concerns in addition to the four oil companies.

Standard Oil Company (New Jersey) continues to rank as the foremost industrial corporation. Its assets at the end of 1947 were reported at $2,995,989,693. The three other billion dollar oil companies include Standard Oil Company (Indiana) with assets of $1,268,103,846 on December 31, 1947, Socony-Vacuum Oil Company with $1,261,974,200, and The Texas Company with $1,115,344,831.

Not far behind Standard of New Jersey is General Motors Corporation with assets of $2,472,969,238. U. S. Steel Corporation reported assets of $2,162,612,907 and E. I. du Pont de Nemours $1,438,-114,642.

U. S. companies with assets of one billion dollars or more numbered only 20 in 1929 and 32 in 1941. The 32 billion dollar concerns of 1941 included only one oil company, Standard Oil Company (New Jersey), which then had assets of $2,202,351,739.

For oil companies in the aggregate, there has been an increase of approximately 45 percent in assets since 1941.

As of December 31, 1947, the reported assets of 23 of the largest oil companies totaled $11,938,593,869, compared with $8,220,369,553 at the end of 1941. The $11,938,593,869 included assets by companies as follows: Atlantic Refining Company, $329,644,730; Barnsdall Oil Company, $41,066,492; Continental Oil Company, $209,224,483; Gulf Oil Corporation, $929,168,890; Houston Oil Company, $54,310,149; Lion Oil Company, $39,348,196; Mid-Continent Petroleum Corporation, $115,647,714; Ohio Oil Company, $163,773,023; Phillips Petroleum Company, $439,289,341; Plymouth Oil Company, $22,346,212; Pure Oil Company, $224,540,177; Richfield Oil Corporation, $109,179,520; Sinclair Oil Corporation, $591,280,181; Skelly Oil Company, $128,997,797; Shell Union Oil Company, $533,911,823; Socony-Vacuum Oil Company, $1,261,974,200; Standard Oil Company of California, $876,185,264; Standard Oil Company (Indiana), $1,268,103,846; Standard Oil Company (New Jersey), $2,995,989,693; Standard Oil Company of Ohio, $188,866,085; The Texas Company, $1,115,344,831; Texas Pacific Coal & Oil Company, $17,600,-000; and Tide Water Associated Oil Company, $262,801,222.

Rail Change Over Won't Waste Fuel

TO A CONSIDERABLE extent the railroads will be able to change over to diesel locomotives without increasing their requirements of fuel oil, stated Harvey T. Hill, executive director of the Diesel Engine Manufacturers' Association to the API Marketing committee. This will be possible, he said, because diesel locomotives use relatively much less oil than the oil-burning steam locomotives they are replacing.

Within the next five years, Hill predicted, about 15 million horsepower will be added to the total of diesel locomotives in operation in the U. S. This will be a tripling of the 7,166,436 horsepower in service in the country today in all types of diesel locomotives.

The thermal efficiency of diesel locomotives, he said, is approximately four times as high as that of oil-burning steam engines that are being replaced. Consequently, the fuel oil requirements for locomotives will be less after the replacement program than at present in many areas.

Britain Shows Way In Nationalizing

DEVELOPMENTS in Britain offer some idea of what might be expected from government control or operation of U. S. industries, such as the petroleum industry is threatened with in the Heselton bill.

Since the British government has taken over the electrical industry, officials of the new state monopoly have warned householders that they will have to pay more for their current. Promises of economies from industrial socialization are not here fulfilled. The government cannot operate this industry more economically than private industry could do.

Officials explain that higher rates are necessary because of higher prices of coal, which makes up half the cost of generating power. However, coal costs also are determined by government operation. British coal prices have been raised four times since the mines were nationalized.

While Britain has nationalized its electric utility industry, the U. S. has made some long steps in the same direction. In its river control programs the U. S. has entered the field of electric power production and marketing, and there has been deliberate misleading of the American public on the costs of the government-produced electricity. Claims have been made that these costs have been very low, but in arriving at these figures highly important factors of cost have been entirely omitted. It cannot be proved with strict accounting procedure that U. S. government-produced electricity is competitive with that produced by the utility companies.

Hiking Octane With Automatic Injection

MOTOR VEHICLES of the future probably will use alcohol-water injection containing tetraethyl lead to suppress knocks. Injection is to be automatic as needed, through a special device. In this way regular grade gasoline has been stepped up as much as 25 octane numbers. This will permit early use of higher compression motors and their large savings in fuel without heavy oil refinery expense in raising octane number.

This trend has been forecast by Arch T. Colwell, vice president of Thompson Products, Inc., Cleveland, an authority on valves and engine parts. He also sees a trend toward infinitely variable transmissions, and lighter, smaller, more easily serviced cars. Smaller cars are indicated, he says, to reduce costs and to relieve traffic congestion, with 37 million cars estimated by 1960.

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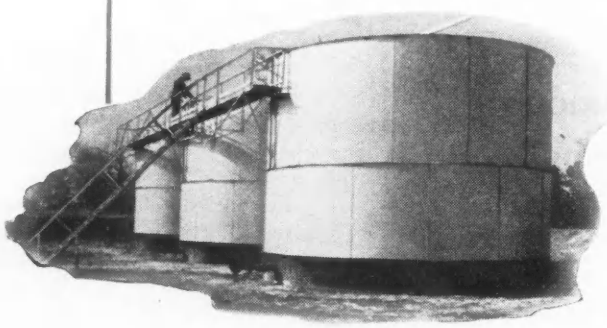

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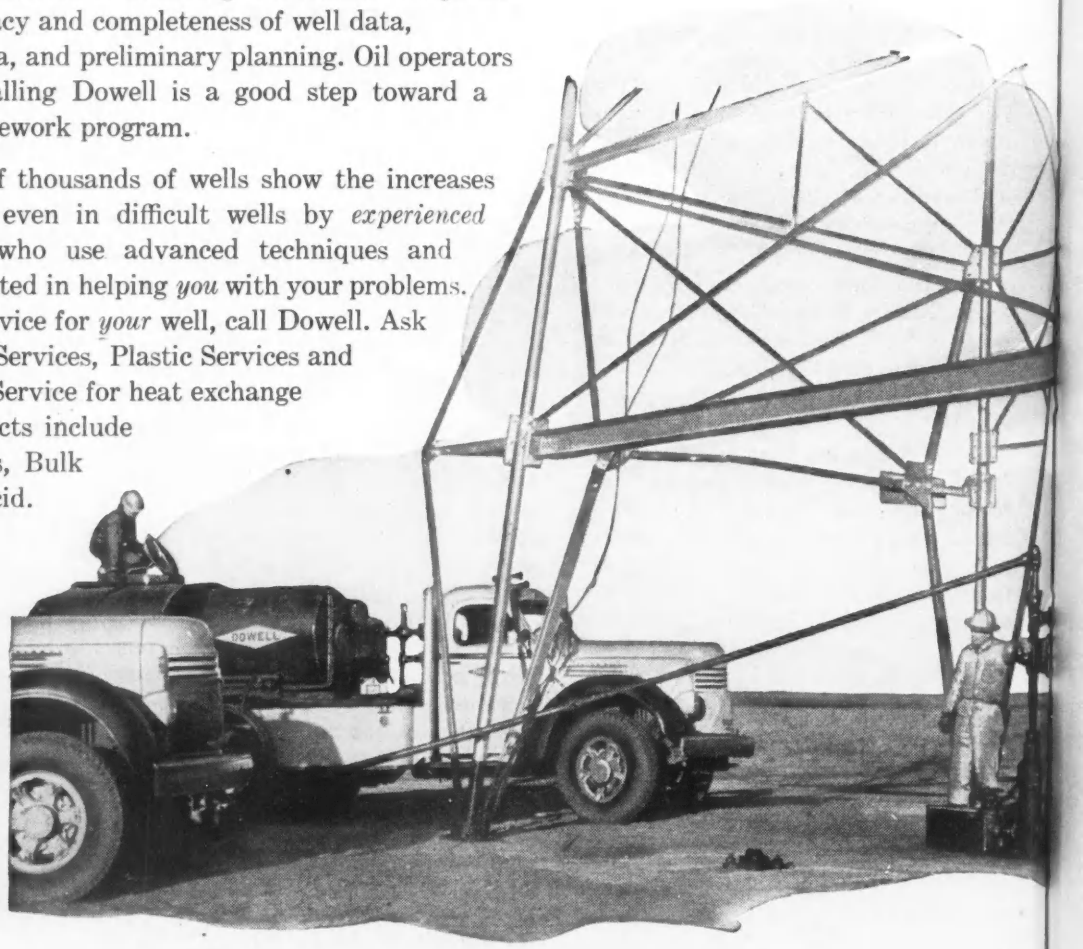

EXAMPLE:

Initial production on a well completed in the Simpson Dolomite of North Texas was 1½ BOPD with opinions expressed that it had no chance to do better. A Dowell Electric Pilot Survey showed nearly all the relative permeability in 12 of the 75 feet of open hole. The well was selectively acidized in three stages using the Electric Pilot to hold the acid to the tighter zones. Results—50 BOPD.

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ONE EXPOSITION IS ENOUGH

THE INTERNATIONAL Petroleum Exposition at Tulsa which closed May 22 was without question the finest and most complete exposition of equipment and services used in the oil industry to date. No one could walk through the grounds and see what was being shown without a greater appreciation of the part modern equipment and service is playing in the oil industry's efforts to provide the world with oil.

Not only were most of the manufacturers of equipment represented with exhibits, but the earnest effort they had put into making the exhibits worthwhile to visiting oil men was apparent on every hand.

Any oil man who missed the exposition missed something very worth while.

The only fly in the ointment was the housing situation, and that proved to be better than generally had been anticipated. As a matter of fact the job of taking care of the several thousand men needed to service the exhibits alone would tax the housing facilities of almost any city in the U. S., but when there was added the problem of taking care of visiting oil men the task became almost superhuman. The people of Tulsa opened their homes to visitors to such an extent that no one who came to Tulsa to attend the exposition was without sleeping accommodations. However, this was not generally known even a few weeks before the Exposition opened and consequently many oil companies did not send as many men to the Exposition as they had planned originally.

Certainly the Exposition deserved the widest attendance because literally millions were spent by the exhibitors in getting ready to receive the visiting oil men. We heard the costs of the individual exhibits plus the expense of servicing them estimated from several hundred dollars in the case of some small exhibits to more than $200,000 in the case of the largest. It probably would not miss the mark far to estimate that the exposition represented (not including the value of the equipment shown) around $6 to $7 million.

Concern was expressed by many as to the frequency of the Exposition. At a breakfast attended by exhibitors and Exposition management, speakers who urged that the show be held once in each four years received heavy applause. As a result of this meeting, Exposition authorities later decided to ask the Petroleum Equipment Suppliers Association to undertake a survey of the wishes of exhibitors. This will be done as soon as possible.

At the meeting with exhibitors, officials of the Exposition pointed out that the Exposition suffered a deficit of around $70,000 this year because of heavy expenditures necessary to put the grounds and buildings back in shape. (The last previous Exposition was held in 1940.)

This is an important point and if the vote of the exhibitors is to hold the show every four years, as was apparently the sentiment, then the space rates for exhibitors will have to be adjusted upward considerably to take care of a recurrence of what happened this year. We do not believe that the exhibitors will object to such a rate increase.

There was something else in the minds of the Exposition management which was touched upon only lightly by President Skelly at the meeting. Tulsa pioneered in oil expositions, and the grounds and facilities of the International Petroleum Exposition represent a large investment. It is true that this investment has come from the manufacturers who have exhibited in the past but, nevertheless, the investment is there. President Skelly, by inference, asked the question as to whether other cities would step in and hold expositions if the International Petroleum Exposition decides to go on a four-year frequency basis.

It is the opinion of WORLD OIL that the industry cannot support a plethora of expositions. We believe that there should be only one, and that it should be held in Tulsa where facilities are already available. Of course the exhibitors cannot legally agree as a unit not to exhibit elsewhere. For several years prior to World War II only two expositions of a national nature were held by the oil business: the International Petroleum Exposition at Tulsa and the Oil World Exposition held at Houston. The executive committee of the Oil World Exposition voted, after the last exposition in Houston, not to hold a show until after the exposition in Tulsa. No meeting of the board of the show at Houston has been held in several years. While there are some who would like to see the Oil World Exposition reinstituted, the majority of opinion is not favorable to it. Probably a meeting of the Houston board will be held within the next month or two at which the matter will be definitely settled.

In summary, we express the hope again that there will be only one petroleum exposition held in the future and that it will be in Tulsa. We express the hope also, that in the handling of housing accommodations, a better method will be developed to let people know well in advance as to where their housing accommodations are located and under what conditions.

Failure to do a better job could easily affect attendance by oil men to the point where the one and only Exposition would be destroyed.

Ray L. Dudley

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MONTHLY NEWS ANALYSIS

INDUSTRY TAKES HOPEFUL VIEW OF CRITICAL OIL SITUATION
COOPERATION OF FARMERS ASKED . . . CRUDE PRODUCTION HIGH
INDUSTRY BORROWS CAPITAL . . . STEEL PRODUCTION RISES

Industry Discounts Dark View of Oil Situation

The United States situation with regard to petroleum for military and civilian purposes is shown to be highly critical or only temporarily difficult, depending on the source of information. As might be expected, the most vociferous alarmists are men of government. The coolest and calmest observers are men of the industry itself, some of whom have helped to oil the nation quite effectively through two wars and therefore have confidence that future emergencies likewise will be successfully met.

No. 1 alarmist lately has been Representative Dewey Short, Republican, Missouri, chairman of the oil subcommittee of the House armed services committee. After holding 30 hearings on 25 days and collecting 2500 pages of testimony, the 11 men of the subcommittee unanimously signed a 23 page report describing the oil situation as very critical and proposing that an appropriate national oil policy be promptly formulated and put in effect. The situation is so critical, asserted the committee, that rationing must be imposed on consumers if the government decides within the next six months that efforts to get them to conserve voluntarily are unsuccessful.

The subcommittee proposed that the President direct the National Security Resources Board to establish immediately a national commission to recommend to Congress within six months a fully rounded oil policy to meet the nation's present and long range needs.

The proposed national commission, according to its proponents, should consider immediately the allocation of steel to the industry and rationing of oil. Other matters suggested for its consideration included government encouragement of synthetic oil plants, stockpiling of oil for the armed services, establishment of more Naval or military reserves, clarification of tidelands ownership, desirability of importing oil. The subcommittee suggested postponement of the use of American steel for building Middle East pipe lines until more propitious international atmosphere develops or until steel shortage diminishes. It suggested use of steel instead for building tankers, expanding domestic operations, and doing work in South America. The subcommittee rejected suggestions that the United States will again become self-sufficient in oil.

In view of the international situation, said the subcommittee, there must be a consideration of the possible necessity of rationing oil products, allocating of supplies, discouraging installation of new oil burners in private homes, putting diesel locomotives into operation, adding millions of automobiles and thousands of busses and trucks a year to the highways, and continuing to double gasoline consumption by farm equipment and air lines, with the national defense thereby jeopardized for lack of petroleum. If consumers do not conserve oil adequately and present scarcity trends continue, then within six months, said the committee, rationing should be imposed.

The Short subcommittee apparently was influenced more by pessimistic testimony of government witnesses than by the more cheerful statements of petroleum industry witnesses. The subcommittee heard 49 witnesses. Of these, 22 were government officials and representatives.

Typical of statements by oil company men was that of Charles S. Jones, president of Richfield Oil Corporation. Jones expressed confidence that industry-government cooperation would find a way through any future emergency just as such cooperation through the Petroleum Administration for War solved the problems of World War II. Jones recalled that when the recent war was over, the Army-Navy Petroleum Board of the Joint Chiefs of Staff said: ". . . at no time did the Services lack for oil in the proper quantities, in the proper kinds, and at the proper places . . . No government agency and no branch of American industry achieved a prouder war record."

Oil men generally do not agree with Representative Short that the nation is in a critical oil situation, judging by most of the recent public utterances of the men of the industry.

Farmers Asked to Help Avoid Shortage of Oils

Oil companies in Oklahoma and Kansas are jointly seeking cooperation of the farmer in making wisest possible use of all petroleum products in his operations this season. It has been estimated that during the next 12 months the industry can supply 4 or 5 percent more oils than during the past year, at the same time making needed additions to stocks. But it is expected that supply and demand will be in delicate balance this summer.

A field of experienced speakers and organizers has been recruited to hold meetings throughout the Oklahoma-Kansas farm belt for the purpose of placing all those engaged in the oil business on area committees who will work closely with farmers in their immediate localities. Farmers will be furnished with information and literature describing current petroleum supply-demand conditions and will be shown how they can economize on the use of oil by keeping their equipment in good working order, by making use of all available storage facilities, and by giving their suppliers advance notice of their oil requirements.

Control of Oil Industry Sought in 30 Measures

Hounding the petroleum industry are many individuals and groups in Washington, seeking to control, restrict, or regulate oil operations. Seriousness of the threat of federal control is indicated by the fact that some 30 measures have already been introduced in the present session of Congress, seeking to impose some sort of control on the oil industry, while more are expected before adjournment.

Refinery Runs and Crude Production at New Highs

While members of Congress and government administrators try to get the nation alarmed over a possible future shortage of petroleum, the industry goes calmly ahead supplying the requirements of all consumers and doing things to assure continued ample supply.

In recent weeks both refinery runs and domestic crude oil production have been pushed to new all time record highs, far above prewar rates and wartime peaks.

U. S. refinery runs of crude oil averaged 5,640,000 barrels daily in the week ended May 15, compared with a previous high of 5,637,000 daily in the week of January 3 this year.

Crude oil production in the United States averaged 5,422,600 barrels daily in the week ended May 15, compared with a previous high of 5,415,000 barrels per day in the week ended April 24.

Besides record domestic production, the industry is bringing in substantial volumes of needed foreign oil to assure balancing of supply with demand, having carried out expansion of foreign as well as domestic facilities.

Of immediate concern is the necessity of meeting heavy seasonal demand for gasoline. It is encouraging that gasoline stocks are over 9 million barrels greater than a year ago, with current production also larger. Even in the Middle West, where gasoline scarcity is threatened later in the year, gasoline stocks are being increased somewhat and are more than one million barrels above a year ago. While the gasoline situation is encouraging, very heavy demand prevails, and consumers will have to be economical and avoid waste to make sure that their requirements will be met.

Oil Companies Borrow To Expand Facilities

The petroleum industry is having to spend such vast amounts in current expansion of facilities that it will be obliged to draw heavily on outside sources of capital again in 1948 as in 1947. In spite of high earnings, 30 representative oil companies will have to raise more than $400 million of net new capital in 1948 in order to meet capital expenditures of $2,300,000. This is the estimate of Joseph E. Pogue, vice president of Chase National Bank. He said half that amount has already been acquired and the funds are being obtained largely by borrowing from banks and insurance companies, although some common and preferred stocks are being sold.

Despite higher oil prices and oil company earnings, the same 30 companies after plowing back approximately two-thirds of net income found it necessary in 1947 to raise $485 million net from capital markets to round out the funds needed for replacements and expansion of facilities and increase in working capital. Of the external capital raised in 1947, 45 percent came from banks, 24 percent from insurance companies, 4 percent from sale of preferred stock, and 26 percent from sale of common stock.

Conservation Necessary To Assure Enough Oil

The outlook for supplying oil requirements in coming months has been generally accepted as being in line with the recent analysis of the American Petroleum Institute committee for study of short term prospects.

Dr. Robert E. Wilson, chairman of Standard Oil Company (Indiana), for example, recently told the API refining division that domestic crude runs should be 7 to 8 percent higher this year than last year. This represents, he said, an increase of 17 percent over the wartime peak and is 44 percent above the prewar peak in 1941—"an amazing achievement in view of the shortages of steel and other materials which have held back our expansion program."

A 7 or 8 percent increase in crude runs over 1947 will not accommodate comfortably an increase in consumption of more than 5 percent, Dr. Wilson said, "as we need to increase stocks on hand by about 2 percent of our annual production if we are to avoid local shortages due to fluctuations in weather conditions and allow for other factors affecting demand and transportation."

The indicated 5 percent increase in petroleum supplies available for domestic consumption in 1948 will be enough to satisfy probable demand, said Dr. Wilson, only "if new oil burner installations return to the relatively low prewar rate, and if consumers continue to cooperate in conservation of both gasoline and oil, and if we have a moderate winter, and if there are no serious strikes in our or other basic industries.

"On the other hand," he continued, "if I should prophesy that we will get by, and the public relying on such predictions should reduce its efforts to conserve oil and gasoline and step up its oil burner installations to even approach those of last year, we would undoubtedly have a shortage much worse than that of last year."

Higher Oil Prices Bring Forth Record Oil Supply

Materially higher first quarter earnings in 1948 than in 1947 have been reported by practically all oil companies. In many cases the profits were about double those a year ago and in some instances triple or more.

Such sharp increases cannot be expected, however, in subsequent quarters unless there are more increases in crude oil and product prices, as there were three general crude price increases in 1947. There were raises of 25 cents per barrel March 10, 20 cents October 15, and 50 cents December 6. Thus crude prices during the first quarter of 1948 were 95 cents a barrel higher than in most of the initial quarter of 1947, with Oklahoma-Kansas 36-gravity lifted by the increases to $2.57 per barrel. Prices of refined products have been advanced proportionally to compensate for the increases in crude postings.

Additional increases in crude oil and product prices are considered undesirable by many in the industry, especially since several steel, electrical manufacturing, and other large companies have announced price reductions in an attack on inflation. If the oil industry should further increase prices in the early future, with high earnings already being reported, it doubtless would bring down upon itself an avalanche of criticism and public disapproval. It is true that large earnings are necessary to raise capital for needed expansion, but present prices are providing those favorable earnings. Furthermore, financial results are sufficiently favorable that stockholders have been given substantial increases in dividends. Thus there has been a bolstering of the industry's ability to borrow or market new stock insofar as that may be needed to supplement the capital supplied in the main from current earnings.

Nevertheless, inflation is an unmanageable thing, and there is no definite assurance that the peak of prices has yet been reached. The new round of wage increases in various industries raises the threat of further price increases, since previous wage raises have been followed promptly by higher prices. Oil companies are among those which lately have granted further increases in wage rates and salaries.

Meanwhile, there is strong pressure upward on prices of crude oil, as refiners experience difficulty in procuring sufficient crude. The head of a major company has warned that another crude price increase is likely as long as refiners offer premium rates for crude oil. The only thing that will definitely prevent still higher crude prices, in the face of strong demand, is an increased supply of crude which will make it unnecessary for refiners to offer premiums to procure enough crude.

In an all-out effort to supply crude for all comers, wildcatters and producers this year are drilling more wells and more footage than ever before in history. And they are discovering and developing large volumes of oil.

While further price increases are to be

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PETROLEUM ELECTRIC POWER ASSOCIATION
Box 1498, Oklahoma City, Oklahoma

avoided if possible, there is no occasion to explain or defend the presently prevailing prices of the oil industry. They are performing successfully the essential function of bringing forth unprecedented supplies of petroleum products. Left free as heretofore, the prices will continue to perform this function of making supply meet demand.

Steel Production Rises 60 Percent Since 1939

The steel industry is like the petroleum industry in that it is being criticized for its difficulty in meeting demand for its products. This criticism is not quite fair for the steel industry, just as it is not fair for the oil industry, because the demand encountered is abnormally heavy and can be supplied only with time and additional production facilities.

Dr. R. E. Zimmerman, vice president of research and technology for United States Steel Corporation of Delaware, in a recent speech, took sharp issue with critics of the steel industry on the question of capacity. He declared that the industry has expended vast amounts in the last eight years to enlarge and improve its facilities. He asserted that the industry had carried on a sound and orderly course of expansion designed to maintain steel prices at the lowest possible level, as at present.

"Steel production last year represented an increase of 60 percent over 1939," asserted Dr. Zimmerman. "Last year, operating at an average 93 percent of rated capacity, the steel industry in the United States produced 84,800,000 tons of ingots, or 63 million tons of finished rolled products. That was between 53 and 54 percent of the total world production of steel. The industry knows and readily admits that it was not enough to satisfy all of the existent demands promptly. It was, however, a remarkable peacetime output and under the conditions a major accomplishment.

"The American steel industry, for many years the largest in the world, has not been accustomed to the unusually rich diet of tonnage developed by the recent World War and its aftermath. Prior to 1940, the 20-year average was a little less than 43 million tons, about one half the 1947 production."

While steel companies have been steadily expanding facilities, said Dr. Zimmerman, progress has been retarded by shortages of skilled workmen, labor, and materials. Ingot capacity of the industry exceeded 94,200,000 tons by January 1, 1948, and one million tons additional will be added in each of the years 1948 and 1949, boosting capacity above 96 million tons early in 1950.

"At an operating rate of 90 percent, the 96 million ton capacity can produce more than 86 million tons of ingots, or in an emergency, at a higher rate, around 92 million tons. The prewar tonnages are dwarfed by such figures."

Dr. Zimmerman also pointed out that new steel mill facilities cost three times as much as similar prewar facilities. Therefore, he warned, the addition of very high cost facilities must be kept within reasonable economic proportions or else higher prices must be secured for the products made and sold. In our present economic situation, he added, higher prices do not constitute a preferred or desirable method of procedure if they can be avoided.

Additional Steel Would Provide More Drilling

Hearings of the Senate small business committee, headed by Senator Wherry, Republican, Nebraska, in the latter part of May brought out various suggestions for channeling steel supplies into essential use in the petroleum industry.

Max Ball, director of the Oil and Gas Division of the Department of Interior, supported the National Petroleum Council's estimates of petroleum industry steel requirements. He asserted that the committee on steel requirements had adopted a conservative view in preparing its estimates, which are for prospective use by the Department of Commerce in sponsoring voluntary industry agreements for supplying steel to the various industries under the Taft law.

A spokesman for the Department of Commerce told the Wherry committee that it planned to launch an exploration on the advisability of seeing what could be done to put idle independent company refining capacity to work instead of channeling steel under proposed voluntary agreements program to major refiners.

The Wherry committee asked 18 major oil companies to report how much tubular goods, excluding line pipe, they had on hand and did not need to complete wells that were being currently drilled. The committee contemplated that if substantial amount of tubular goods was "immobilized" in inventories, steps would be taken to try to "shake some of it loose."

Russell B. Brown, general counsel for Independent Petroleum Association of America, declared to the Senate small business committee that more steel than necessary was being exported from the United States because of undue "pressure" from the executive branch of the government. He recommended that arrangements be worked out with the steel industry, on voluntary basis, for steel producers to provide supplies for current production only and not for building up inventories. If this is done, he said, independent refiners with idle capacity will be supplied with plenty of oil. Chairman Wherry of the committee had remarked that studies of his committee showed that independent refiners were operating at only 67 percent of capacity because of inability to obtain crude oil. Brown also again protested against construction of the Trans-Arabian pipe line, which he asserted would not add a barrel of production but only serve as a transportation convenience to the owners. Brown declared that if sufficient steel were available, 40,000 new wells per year would be drilled in the United States, compared with an estimated 37,600 this year.

J. E. Warren, president of Carl B. King Drilling Company, of Midland, Texas, and chairman of the IPAA committee on material shortages, told the Wherry committee that 300 to 400 drilling rigs now inactive could be put into service if additional steel casing could be obtained.

Advertising in Middle West To Urge Saving of Gasoline

The Middle West is expected to feel the pinch on gasoline supply this summer and fall to perhaps greater extent than other areas. However, oil companies that supply the region are taking all possible precautions to avoid shortages. While they are making vigorous efforts to provide largest possible volumes of supply, they also are actively and systematically seeking to get the public to cut out unnecessary and wasteful use of gasoline, so that there will be enough for all essential requirements. Through wide-scale advertising they are seeking to impress upon the public that balancing of supply of gasoline with demand requires not only that oil companies maximize supply but also that consumers minimize demand.

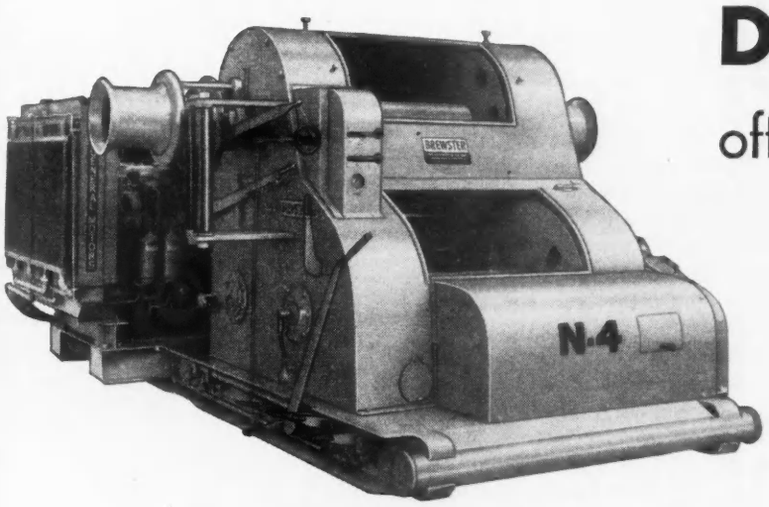
Standard Oil Company (Indiana), for example, which markets in numerous Middle Western states, has already commenced an extensive summer advertising campaign in which it will repeatedly tell motorists how they can save gasoline and thereby help to make sure that there will be enough for all. Newspapers, radio, outdoor posters, a gasoline conservation display card, curb signs at service stations, and a folder on "How to Save Gasoline" for dealers to give motorists will be used in the advertising campaign throughout the 15 Mid-West states where the company markets.

Voluntary gasoline conservation measures which the advertising will suggest to motorists include the following: (1.) Eliminate unnecessary driving. (2.) Or-

FOR DRILLING 4500′ to 5500′

THE N-4 DRAWWORKS

offers these features . . . . .



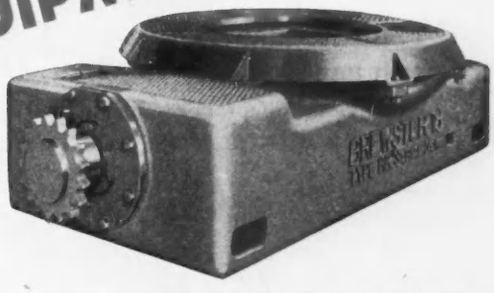
☆ **TORQUE CONVERTER Provides fluid cushioned power to handle any load with the flexibility of steam.**

☆ **HYDROMATIC BRAKE For smoother and easier return trips.**

☆ **AIR CONTROLLED. Greater ease, speed, and safety in drilling operations.**

☆ **UNITIZED ON SINGLE SKID Easy to move—easy to rig up.**

WITH MATCHED EQUIPMENT



RS-18 OILBATH ROTARY

4-S OILBATH SWIVEL

H-100 HOOK BLOCK

BREWSTER *Drilling Equipment*

THE BREWSTER CO., INC.

Manufacturers of Drilling Equipment Since 1910

SHREVEPORT, LOUISIANA, U.S.A.

WRITE FOR FREE CATALOGS

ganize car pools. (3.) Drive at moderate speeds. Increasing speed from 40 to 60 miles per hour increases gasoline consumption about 40 percent. (4.) Avoid "jack rabbit" starts and prolonged low-gear operation. (5.) Keep tires properly inflated. (6.) Keep car in efficient operating condition by having spark plugs serviced, valves flushed, oil changed frequently.

The Standard of Indiana summer advertising campaign will include seven weekly advertisements in newspapers. A total of 1766 newspapers, including 1293 weeklies and 473 dailies, with a combined circulation of more than 16,000,000 will be used. The need for conservation of gasoline will be told in all seven newspaper ads. Radio advertising by the company will include announcements on 123 broadcasts per week over 21 stations. Five monthly 24-sheet posters will appear on more than 3300 outdoor boards at points of heavy traffic, and there will be five monthly curb signs at Standard Oil dealer stations.

New Catalyst Gives More Gasoline from Crude Oil

Almost 25 percent more gasoline can be produced from crude oil by using a new catalyst, or chemical stimulant, called silica-magnesia, a combination of dried out milk of magnesia and common white sand, revealed three Esso Standard Oil Company men to the American Chemical Society.

Oil Now Sought at Great Depth and Beneath Ocean

In fulfillment of promises that it will do all in its power to expand supply of its products, the petroleum industry currently is carrying on difficult and costly exploratory drilling of pioneering nature. On the one hand, it is intensifying development of production at depths below 12,000 feet. In the second place, it is stepping up its development of the indicated reserves of the marginal sea, though this latter work still is held back by the federal government's usurpation of the traditional states' rights to the submerged coastal lands.

In the past few months there have been several discoveries of very deep fields, one of them having set a new world record for deep production. Pure Oil Company obtained flow of 1413 barrels of 44 gravity oil through ¾-inch choke in 41 hours from 120 feet of Frontier sand at 14,309 feet in a drill stem test of a well on the West Poison Spider prospect of Natrona County, Wyoming. The company proposed to complete the well in that sand. It was the world's deepest production, surpassing the depth of slightly more than 14,000 feet from which a Stanolind Oil & Gas Company well in Grady County, Okla., was completed recently.

Another apparently important deep field discovered recently is the Cross Roads pool of northeastern Lea County, N. Mex., opened by Mid-Continent Petroleum Corporation. The wildcat discovery well is Sawyer 1, 35 miles from nearest production in the Caprock field of New Mexico, and 40 miles from production in Cochran County, West Texas. The well was completed with a potential of 3980 barrels of 42.5 gravity oil per day from Devonian lime perforations at 12,115-12,215 feet, and has been assigned an allowable of 500 barrels per day. It is believed that the strike may develop into an important reserve, and there is some possibility that it may later yield deeper production from the so far untested Ellenburger lime, which is a rich source in some fields of the general area.

There are less than 20 fields yielding oil, condensate, or gas from depths below 12,000 feet, and only a few of these have shown definite promise of being profitable, in view of the high costs of such deep drilling. However, the Pure Oil well in Wyoming and the Mid-Continent discovery in New Mexico offer added encouragement of 12,000-foot development. Another fairly recent 12,000-foot discovery of special interest was the Benedum field of Upton County, West Texas. Three wells are being drilled in the field and are expected to be completed within about two months.

While wells are being drilled to these great depths, they also are being drilled in gradually increasing numbers on the open ocean along the Gulf Coast. The off-shore wells like the very deep ones are very costly, especially in the present pioneering stage of this kind of drilling. One of the particularly interesting current off-shore drilling operations is that of Humble Oil & Refining Company, described and pictured on page 77.

Horses and Mules Being Replaced by Power Tools

Heavy use of petroleum products on farms has reduced horses and mules in the U. S. to 10 million head in 1947 from 14 million in 1941. Power tools that are replacing horses and mules include wheeled tractors, crawler tractors, garden tractors, harvesters of cane, rice, and cotton, hay balers with auxiliary engines, manure spreaders, grain elevators with their own power units, and dozens of other fuel-using machines, all dependent on oil.

Tractors that formerly worked a few hundred hours a year are now working over a thousand. Even winter does not stop them, as they are then used to saw wood, spray paint, chop feed, and for many other jobs.

Oil Men Fear Beginnings Of Bureaucratic Control

This session of Congress does not appear likely to bring favorable governmental action on two matters of great importance to the petroleum industry: (1) curbing powers of the Federal Power Commission over production of natural gas or oil and (2) quitclaim of title to the marginal sea by the federal government, in favor of the states.

In these matters men of the petroleum industry fear the beginnings of bureaucratic controls that will strangle the industry and do great damage to the public interest.

The Rizley-Moore bill, H. R. 5401, to amend the natural gas act so as to deny F.P.C. power to control production of gas or oil, was killed in the middle of May by a 9 to 4 vote of the Senate interstate and foreign commerce committee. This action was interpreted as destroying any hope of revising during this session the law under which F.P.C. regulates rates of interstate natural gas pipe lines. The fact that the senate remains heavily weighted with Democrats determined the vote. All six Democrats on the committee and three of the seven Republican members voted against the bill, which previously had been passed by a heavy majority in the more predominantly Republican House of Representatives.

On the tidelands question a similar situation exists. By overwhelming majority the title to the marginal sea was conceded to the states in the House of Representatives, but there was a delaying action in committee in the Senate. Even passage by the Senate would not mean a law, it was realized, as it was taken for granted the President would veto any bill enacted. While the House could override a veto the Senate probably would not.

On both of these important questions the governmental group most directly representative of the people, the House of Representatives, has voted against bureaucratic controls. But the will of the people is being blocked by the old, entrenched bureaucracy, as found in the Senate, the White House, and the Supreme Court. There can be no sudden curbing of a bureaucracy built up over 15 years and still entrenched in the White House, the Cabinet, the Senate with its six year terms, and the Supreme Court with its lifetime appointments.

In the election two years ago the country voted that it had "had enough," but if it wants real relief from the bureaucrats it will have to keep voting that way for many more years.

He works for you

He's a field engineer specializing in wire-rope problems. He works for Bethlehem, but he also works for you.

Let's say you operate machinery that uses wire rope. Maybe you haven't been getting maximum service from your lines and don't even realize it. Maybe they haven't been lasting as long as they should, and it's costing you money, whether you know it or not.

A spot like that is where the Bethlehem man can help. He knows wire rope, all the many sizes and types and grades. He also knows the kind of machines you use—how they work, what they do; why they need a certain lay of rope, a certain type of core.

If you'll ask him to study your needs, he'll give you a prompt analysis and recommend the proper ropes. He'll show you ways to get the most out of them. Both are points that have a vital bearing on rope life and efficiency.

No matter where you are, the Bethlehem man is glad to be of service to you. Call him in whenever you need him... doesn't cost you a penny.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

When you think WIRE ROPE ... think BETHLEHEM

Looking Ahead

VENEZUELA is not likely to grant new acreage for oil concessions, according to Dr. Jose Martarano Battisti, of the Ministry of Fomento, who indicated it is the desire of the nation to see present concessions more fully exploited before granting others. This statement of policy is in line with observations previously expressed in World Oil (January, 1948, P.17).

WORLD OIL ATLAS coming next month will be most comprehensive work of its kind ever published. Issue will contain 86 pages of pertinent data on all the world's active oil areas and 66 pages of color maps, plus much other valuable information.

AFTER TWO or three years pipe lines in Middle East and refineries there and in Europe should supply European oil needs and free much South American oil for supplying further growth in U. S. demand, predicts Dr. Robert E. Wilson, chairman of Standard Oil Company (Indiana).

WITHIN A few years Continental Shelf will substantially contribute oil for U. S. consumption, it is expected, provided federal government gives up claim to title.

ALTHOUGH THERE are now 3 million tractors on U. S. farms or double the ½ million of 1940, 1,200,000 more are needed to further mechanize agriculture and to maintain present level of food production. Horse population has dropped from 27 million in 1918 to 9 million now.

REPORTS FROM COLOMBIA add to speculation over the government's disposition of Tropical Oil Company's De Mares concession when it reverts in August, 1951. The National Petroleum Council may recommend operation by a Tropical-Colombian government joint company.

SUPPLY OF lubricating oils will be ample during the next four years. Facilities for making lubes undoubtedly will be considerably in excess of demand by 1951. So predicts A. J. McIntosh, Socony-Vacuum Oil Company economist.

AUTOMOBILE MAKERS envisage 12½ to 1 compression ratio motors using 100 plus octane gasoline at 35 to 40 percent saving in fuel. Within year or two they will step up compression ratio from present 6½ or 7 to 1 using 88 octane to 8 or 8½ to 1 requiring 93 octane, which some oil companies say they can supply.

TEN YEARS from now the U. S. may be importing 1 million barrels of oil per day. In the next ten to 20 years it may have an important synthetic fuel industry, if Western Hemisphere petroleum production falls short of requirements. Standard Oil Company (New Jersey) made these predictions in its magazine, The Lamp.

IF A COAL strike occurs in July it will have crippling effect on the steel industry and the whole national economy. warns T. N. Girdler, chairman of Republic Steel Corporation. Petroleum industry would be seriously hurt by shortage of steel.

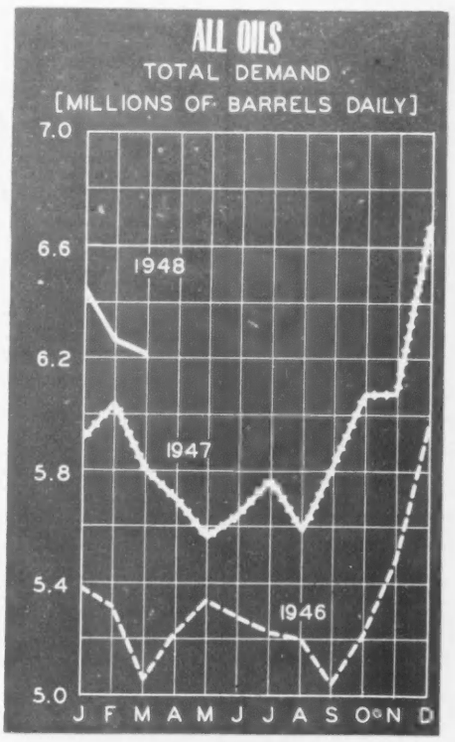
Supply 50% Above Prewar

THE petroleum industry is demonstrating a high degree of efficiency and ingenuity in supplying constantly increasing volumes of oils despite its inability to procure all the materials it needs for expanding its facilities.

In the first quarter of 1948 the industry furnished oils to consumers at the record-breaking rate of 6,310,000 barrels daily. That was 6.6 percent more than the 5,917,000 barrels per day of demand supplied in the initial quarter of 1947. It was over 50 percent more than the 4,068,000 barrels per day of total demand in the first three months of 1941, last prewar year for the United States.

The volume of supply made available in the first quarter of 1948 was in line with the trend to be expected in the remainder of this year, as forecast by the American Petroleum Institute committee that studied prospective short-term availability. That committee estimated that for the 12 months beginning April 1, 1948, available supply would be 8 percent greater than in the preceding 12 months. It warned, however, that part of that supply should go into expansion of stocks, lest it be necessary to continue emergency distribution measures and threats of spot shortages. If stocks are built up as needed, the committee stated, the supply available for current consumption will be only about 4 to 5 percent more than one year previously.

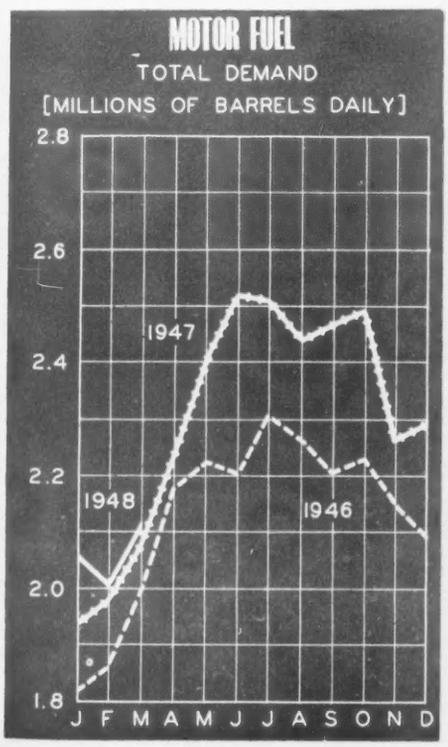
Increase in supply of petroleum products has been achieved almost wholly by expanding domestic production of crude oil and natural gasoline, as imports have shown no material change from a year ago. Stocks of crude oil and refined products followed usual seasonal trends in this year's first quarter.

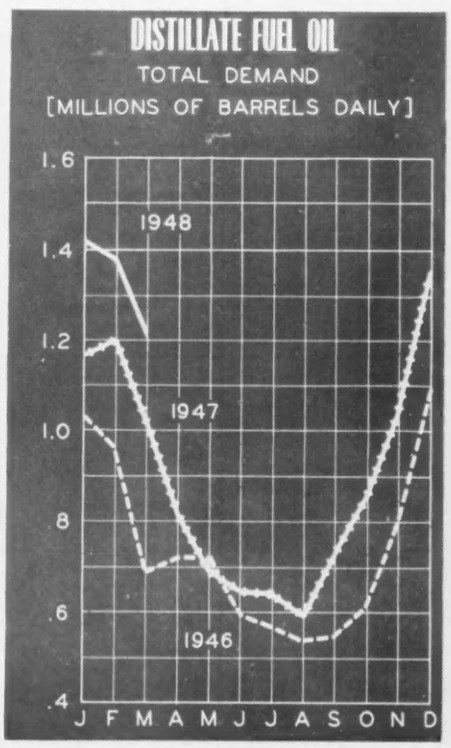


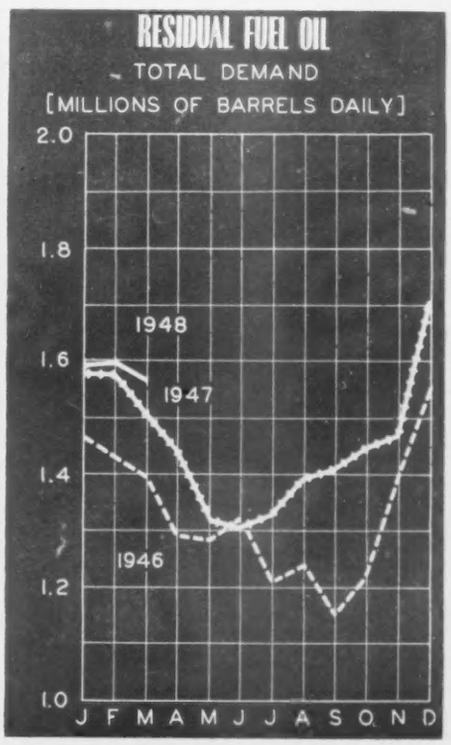
(See table on next page.)

United States production of crude oil averaged 5,318,000 barrels daily in the first three months of 1948. This was a noteworthy achievement, exceeding what might have been thought possible a year ago. This production was 522,000 barrels a day or 10.9 percent more than the output of 4,796,000 barrels daily in the first quarter of 1947. It was 1,715,000 barrels a day or nearly 50 percent more than the production of 3,603,000 barrels daily in the initial quarter of 1941. Reports by weeks showed that U. S. crude production climbed as high as 5,415,000 barrels daily in the week ended April 24.

Refinery throughput likewise has exceeded earlier expectations. Crude runs to stills at U. S. refineries averaged 5,370,000 barrels daily in the first quarter of 1948. This was 570,000 barrels a day or 11.9 percent more than the runs of 4,800,000 daily in the first three months of 1947. It was 1,790,000 barrels a day or exactly 50 percent more than the runs of 3,580,000 daily in the initial quarter of 1941. In the week ended April 10 of this year, refinery runs were well above the first quarter average, having climbed to 5,568,000 barrels daily for that seven day period.







Demand for and Supply of All Oils, Crude Oil, Motor Fuel, Kerosine, Fuel Oil and Lubricants

Sources: U. S. Bureau of Mines except February and March, 1948, estimated with aid of A.P.I. reports

(THOUSANDS OF BARRELS)

ITEM	First 3 Months 1941	First 3 Months 1947	First 3 Months 1948	Percent Difference 1947-1948
ALL OILS				
Domestic Production, Total	339,530	463,281	519,741	+ 12.2
(Daily Average)	3,773	5,148	5,711	+ 10.9
Crude Petroleum	324,255	431,653	483,894	+ 12.1
(Daily Average)	3,603	4,796	5,318	+ 10.9
Natural Gasoline	14,365	31,388	35,697	+ 13.7
(Daily Average)	160	349	392	+ 12.3
Benzol	910	240	150	— 37.5
(Daily Average)	10	3	2	— 50.0
Imports, Total	21,259	43,420	43,145	— 0.6
(Daily Average)	236	482	474	— 1.7
Crude Petroleum	9,985	25,470	25,666	+ 0.8
(Daily Average)	111	283	282	— 0.4
Refined Products	11,274	17,950	17,479	— 2.6
(Daily Average)	125	199	192	— 3.5
Changes in Stocks, All Oils	—5,285	—25,826	—11,347	.....
(Daily Average)	—59	—287	—125	.....
Stocks, Beginning of Period	562,647	507,094	500,800	— 1.2
Refinable Crude	264,079	224,473	224,929	+ 0.2
Heavy Crude in California	11,906	5,703	5,725	+ 0.4
Refined Products	280,958	271,937	265,850	— 2.2
Natural Gasoline	5,704	4,981	4,296	— 13.8
Stocks, End of Period	557,362	481,268	489,453	+ 1.7
(Days' Supply)	137	81	78	— 3.7
Refinable Crude	266,380	228,981	222,930	— 2.6
Heavy Crude in California	11,776	5,999	6,635	+ 10.6
Refined Products	273,875	241,023	255,065	+ 5.8
Natural Gasoline	5,331	5,265	4,823	— 8.4
Demand, Total	366,074	532,527	574,233	+ 7.8
(Daily Average)	4,068	5,917	6,310	+ 6.6
Exports, Total	19,686	37,914	28,135	— 25.8
(Daily Average)	219	421	309	— 26.6
Crude Petroleum, Total	5,017	8,736	9,592	+ 9.8
(Daily Average)	56	97	105	+ 8.2
Refined Products, Total	14,669	29,178	18,543	— 36.4
(Daily Average)	163	324	204	— 37.0
Domestic Demand, Total	346,388	494,613	546,098	+ 10.4
(Daily Average)	3,849	5,496	6,001	+ 9.2
CRUDE PETROLEUM				
Supply:				
Domestic Production, Total	323,753	431,653	483,894	+ 12.1
(Daily Average)	3,597	4,796	5,318	+ 10.9
Imports, Total	9,985	25,470	25,666	+ 0.8
(Daily Average)	111	283	282	— 0.4
Change in Stocks (incl. Calif. hvy)	+2,166	+4,804	—1,089	.....
(Daily Average)	+24	+53	—12	.....
Stocks, Beginning of Period	276,615	230,176	230,654	+ 0.2
Stocks, End of Period	278,781	234,980	229,565	— 2.3
(Days' Supply)	76	47	41	— 12.8
Supply, Total	331,572	452,319	510,649	+ 12.9
(Daily Average)	3,684	5,026	5,612	+ 11.7
Demand:				
Runs to Stills, Total	322,187	431,970	488,666	+ 13.1
(Daily Average)	3,580	4,800	5,370	+ 11.9
Domestic Crude	311,814	407,885	463,546	+ 13.6
(Daily Average)	3,465	4,532	5,094	+ 12.4
Foreign Crude	10,373	24,085	25,120	+ 4.3
(Daily Average)	115	268	276	+ 3.0
Exports, Total	4,946	8,736	9,592	+ 9.8
(Daily Average)	55	97	105	+ 8.2
Transfers to Fuel Oil Stocks	2,921	6,746	7,302	+ 8.2
(Daily Average)	32	75	81	+ 8.0
Distillate Fuel Oil	630	718	863	+ 20.2
Residual Fuel Oil	2,291	6,028	6,439	+ 6.8
Used as Fuel, and Losses	1,581	4,867	5,089	+ 4.6
(Daily Average)	17	54	56	+ 3.7
Demand, Total	331,572	452,319	510,649	+ 12.9
(Daily Average)	3,684	5,026	5,612	+ 11.7
KEROSINE				
Production, Total	18,582	28,134	32,932	+ 17.1
(Daily Average)	206	312	362	+ 16.0
Percent Yield from Crude	5.8	6.5	6.7	.....
Imports, Total	43	.....	.....	.....
(Daily Average)	.....	.....	.....	.....
Change in Stocks	—2,788	—7,270	—6,994	.....
(Daily Average)	—31	—81	—77	.....
Stocks, Beginning of Period	9,512	17,081	17,722	+ 3.8
Stocks, End of Period	6,724	9,811	10,728	+ 9.3
(Days' Supply)	28	25	24	— 4.0
Demand, Total	21,413	35,404	39,926	+ 12.8
(Daily Average)	238	393	439	+ 11.7
Exports, Total	339	2,469	553	— 77.6
(Daily Average)	4	27	6	— 77.8
Domestic Demand	21,074	32,935	39,373	+ 19.5
(Daily Average)	234	366	433	+ 18.3

ITEM	First 3 Months 1941	First 3 Months 1947	First 3 Months 1948	Percent Difference 1947-1948
MOTOR FUEL				
Production, Total	154,325	193,090	213,961	+ 10.8
(Daily Average)	1,715	2,145	2,351	+ 9.6
Refinery Gasoline, Total	139,050	171,220	189,848	+ 10.9
(Daily Average)	1,545	1,902	2,086	+ 9.7
Percent Yield from Crude	43.2	39.6	38.3	.....
Natural Gasoline, etc	14,365	31,388	35,697	+ 13.7
(Daily Average)	160	349	392	+ 12.3
Less Sales of L.P.G.	.....	9,331	11,224	+ 20.3
Less Transfers Cycle Prods	.....	427	510	+ 19.4
Benzol	910	240	150	— 37.5
Imports, Total	1	.....	17	.....
(Daily Average)	.....	.....	.....	.....
Change in Stocks	+13,185	+12,702	+22,040	.....
(Daily Average)	+ 146	+ 141	+ 242	.....
Stocks, Beginning of Period	83,647	89,515	87,407	— 2.4
Finished Gasoline	77,943	84,534	83,111	— 1.7
Natural Gasoline	5,704	4,981	4,296	— 13.8
Stocks, End of Period	96,832	102,217	109,447	+ 7.1
(Days' Supply)	62	51	52	+ 2.0
Finished Gasoline	91,501	96,952	104,624	+ 7.9
Natural Gasoline	5,331	5,265	4,823	— 8.4
Demand, Total	141,141	180,388	191,938	+ 6.4
(Daily Average)	1,568	2,004	2,109	+ 5.2
Exports, Total	5,036	12,833	6,535	— 49.1
(Daily Average)	56	142	72	— 49.3
Domestic Demand	136,105	167,555	185,403	+ 10.7
(Daily Average)	1,512	1,862	2,037	+ 9.4
DISTILLATE FUEL OIL				
Production, Total	47,076	71,454	99,880	+ 39.8
(Daily Average)	523	794	1,098	+ 38.3
Percent Yield from Crude	14.6	16.5	20.3	.....
Transfers from Crude	630	718	863	+ 20.2
(Daily Average)	7	8	9	+ 12.5
Imports, Total	1,257	1,314	1,321	+ 0.5
(Daily Average)	14	15	15	.....
Change in Stocks	—12,931	—28,197	—19,528	.....
(Daily Average)	—144	—313	—215	.....
Stocks, Beginning of Period	42,940	59,620	51,081	— 14.3
Stocks, End of Period	30,009	31,423	31,553	+ 0.4
(Days' Supply)	44	28	24	— 14.3
Demand, Total	61,894	101,683	121,592	+ 19.6
(Daily Average)	688	1,130	1,336	+ 18.2
Exports, Total	3,423	5,423	4,133	— 23.8
(Daily Average)	38	60	45	— 25.0
Domestic Demand	58,471	96,260	117,459	+ 22.0
(Daily Average)	650	1,070	1,291	+ 20.7
RESIDUAL FUEL OIL				
Production, Total	81,795	108,656	116,586	+ 7.3
(Daily Average)	909	1,207	1,281	+ 6.1
Percent Yield from Crude	25.4	25.0	23.7	.....
Transfers from Crude	2,291	6,028	6,439	+ 6.8
(Daily Average)	25	67	71	+ 6.0
Imports, Total	9,682	15,776	15,379	— 2.5
(Daily Average)	108	175	169	— 3.4
Change in Stocks	—6,405	—9,691	—5,606	.....
(Daily Average)	—71	—108	—62	.....
Stocks, Beginning of Period	89,304	47,094	47,091	.....
Stocks, End of Period	82,899	37,403	41,485	+ 10.9
(Days' Supply)	74	24	26	+ 8.3
Demand, Total	100,173	140,151	144,010	+ 2.8
(Daily Average)	1,113	1,557	1,583	+ 1.7
Exports, Total	3,183	2,692	2,040	— 24.2
(Daily Average)	35	30	23	— 23.3
Domestic Demand	96,990	137,459	141,970	+ 3.3
(Daily Average)	1,078	1,527	1,560	+ 2.2
LUBRICATING OILS				
Production, Total	8,278	12,609	12,768	+ 1.3
(Daily Average)	92	140	141	+ 0.7
Percent Yield from Crude	2.6	2.9	2.6	.....
Imports, Total	.....	20	.....	—100.0
(Daily Average)	.....	.....	.....	.....
Change in Stocks	—130	+451	+249	.....
(Daily Average)	—1	+5	+3	.....
Stocks, Beginning of Period	8,767	7,564	*7,701	*
Stocks, End of Period	8,637	8,015	*7,950	*
(Days' Supply)	93	59	*58	*
Demand, Total	8,408	12,178	12,519	+ 2.8
(Daily Average)	93	135	138	+ 2.2
Exports, Total	1,981	3,618	3,290	— 9.1
(Daily Average)	22	40	36	— 10.0
Domestic Demand	6,427	8,560	9,229	+ 7.8
(Daily Average)	71	95	102	+ 7.4

* 1948 Lubricant stocks on new basis excluding distributors' stocks in California.

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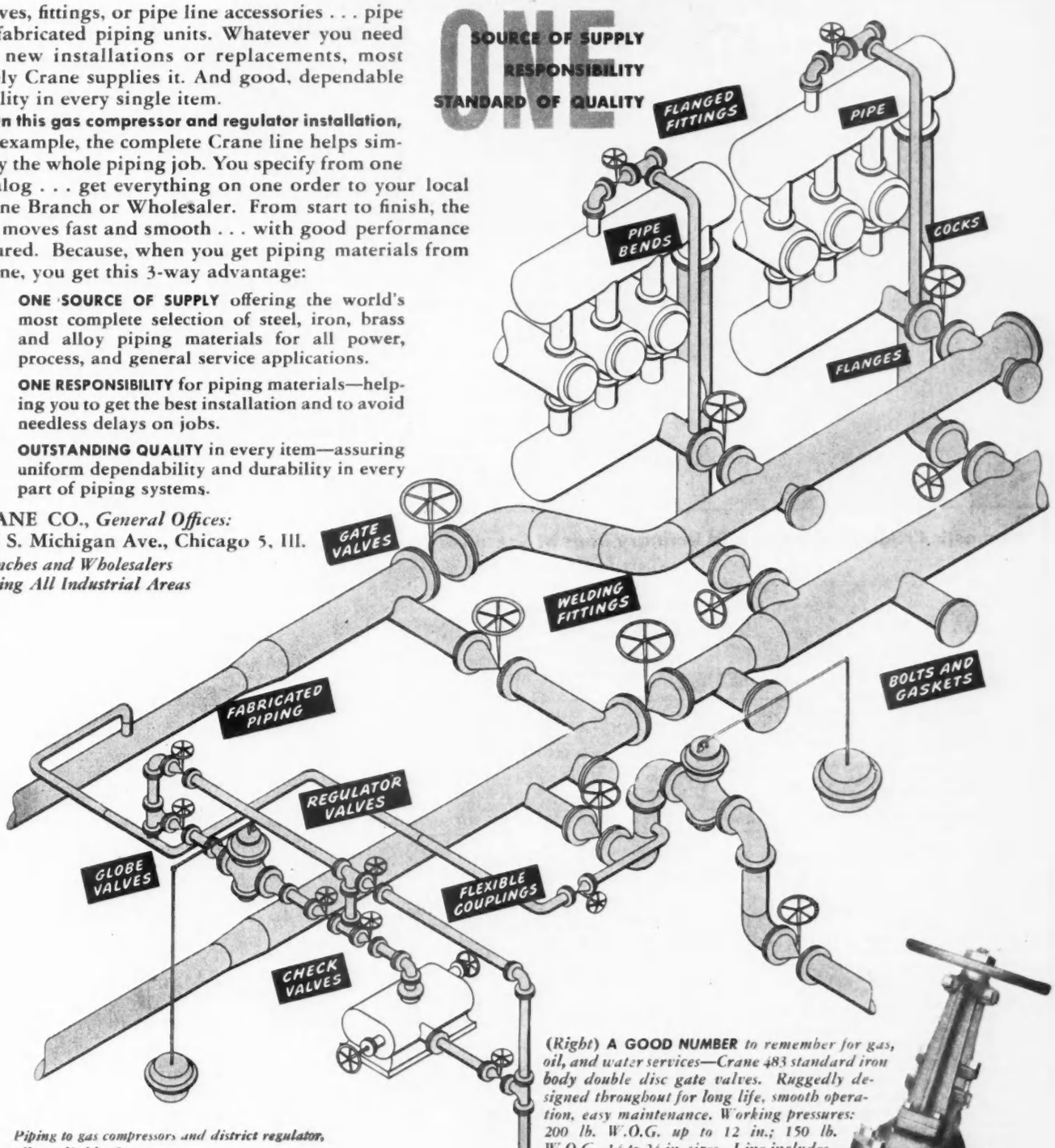

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Competition Keen in U. S. Producing AND Refining

By L. J. LOGAN
Associate Editor

THE great magnitude and the higly competitive nature of the petroleum industry of the U. S. are reflected in the table herewith showing crude oil production and refinery runs of almost 30 companies. The table also shows the indicated production and refinery runs for the rest of the industry.

The industry is so widely scattered from the standpoint of production that 29 larger companies accounted for less than two-thirds of the national total in 1947. The other 37 percent of production is provided by thousands of smaller concerns and operators.

Refining entails relatively large investment and rapid obsolescence, with the result that it is more concentrated than production. However, 25 companies in 1947 accounted for 86.4 percent of U. S. crude runs to stills, while the other 13.6 percent of refinery runs represented smaller-company operations.

These figures indicate much competition in the petroleum industry in the production and refining divisions, to say nothing of the highly competitive mar-

Domestic Crude Production and Refinery Runs of Some Larger U. S. Companies, Years 1946 and 1947
(Data from Annual Reports of Companies)

COMPANY	Net Domestic Crude Oil Production (Company's Net Share: Does Not Include Royalty and Co-Owner Interests)				Crude Oil Run to Stills			
	Total Barrels		Barrels Daily		Total Barrels		Barrels Daily	
	1946	1947	1946	1947	1946	1947	1946	1947
Amerada Petroleum Corporation	18,091,225	20,066,667	49,565	54,977	.....	.....	.....	.....
The Atlantic Refining Company	23,578,000	24,333,000	64,597	66,666	44,656,000	50,322,000	122,345	137,868
Barnsdall Oil Company	9,701,436	10,312,286	26,579	28,252	.....	.....	.....	.....
Cities Service Company	26,318,000	29,264,000	72,104	80,175	56,613,000	64,555,000	155,104	176,863
Continental Oil Company	34,980,359	38,308,687	95,837	104,955	16,749,069	28,426,227	45,888	77,880
Deep Rock Oil Corporation	2,880,000	2,756,000	7,890	7,551	4,405,000	4,350,000	12,069	11,918
Gulf Oil Corporation	75,124,066	78,882,505	205,819	216,116	125,016,741	134,897,459	342,512	369,582
‡Humble Oil & Refining Company	112,967,500	125,268,000	309,500	343,200	73,876,000	83,001,000	202,400	227,400
Lion Oil Company	3,585,007	4,111,573	9,822	11,265	6,034,128	6,466,825	16,532	17,717
Mid-Continent Petroleum Corporation	6,669,926	7,246,861	18,274	19,854	12,697,620	12,926,598	34,788	35,415
The Ohio Oil Company	31,403,870	33,049,523	86,038	90,547	7,536,000	8,667,000	20,647	23,745
Panhandle Prod. & Refg. Company	798,136	1,255,291	2,187	3,439	1,667,006	1,596,699	4,567	4,375
Phillips Petroleum Company	33,542,092	34,740,758	91,896	95,180	29,378,648	31,670,183	80,489	86,768
Plymouth Oil Company	3,754,038	4,113,794	10,285	11,271	.....	.....	.....	.....
The Pure Oil Company	27,902,000	25,804,000	76,444	70,696	32,524,000	29,081,375	89,107	79,675
Richfield Oil Corporation	8,978,270	9,484,870	24,598	25,986	24,276,000	25,734,000	66,510	70,504
Shell Union Oil Corporation	65,224,000	71,356,000	178,696	195,496	99,403,000	102,934,000	272,337	282,011
Sinclair Oil Corporation	26,825,122	28,884,694	73,493	79,136	92,295,845	89,990,046	252,865	246,548
Skelly Oil Company	13,599,803	17,829,454	37,260	48,848	10,575,578	11,724,951	28,974	32,123
Socony-Vacuum Oil Company, Inc.	60,590,000	60,909,375	166,000	166,875	150,380,000	167,900,000	412,000	460,000
South Penn Oil Company	4,450,080	3,881,410	12,192	10,634	.....	.....	.....	.....
Standard Oil Company of California	79,460,936	89,295,750	217,701	244,646	88,585,680	98,748,966	242,700	270,545
Standard Oil Company (Indiana)	64,533,584	71,811,680	176,804	196,744	124,432,303	135,096,034	340,910	370,126
Standard Oil Company (New Jersey)	133,955,000	145,270,000	367,000	398,000	229,585,000	256,595,000	629,000	703,000
The Standard Oil Company (Ohio)	8,965,095	9,625,866	24,562	26,372	30,510,211	34,045,966	83,590	93,277
Sun Oil Company	28,919,478	33,079,593	79,231	90,629	57,890,728	59,399,386	158,605	162,738
Sunray Oil Corporation	9,491,460	12,435,253	26,004	34,069	3,489,925	4,908,789	9,561	13,449
The Texas Company	84,071,329	89,751,538	230,332	245,895	132,545,992	139,097,232	363,140	381,039
Tide Water Associated Oil Company	31,437,689	32,295,523	86,131	88,481	58,842,115	63,883,466	161,211	175,023
Union Oil Company of California	25,517,000	27,743,000	69,910	76,008	34,352,000	36,976,000	94,115	101,304
* Total Above Companies	944,347,001	1,017,899,041	2,587,252	2,788,764	1,474,441,589	1,599,975,202	4,039,566	4,383,494
(Percent of U.S. Total)	54.5	54.8	54.5	54.8	85.2	86.4	85.2	86.4
†Royalty & Co-Owner Oil Produced, Est.	141,109,322	152,099,857	386,601	416,712	.....	.....	.....	.....
†Gross Prod., Above Companies, Est.	1,085,456,323	1,169,998,898	2,973,853	3,205,476	.....	.....	.....	.....
(Percent of U.S. Total)	62.6	63.0	62.6	63.0	.....	.....	.....	.....
Rest of Industry	648,482,677	686,108,102	1,776,665	1,879,749	255,755,411	252,270,798	700,700	691,153
(Percent of U.S. Total)	37.4	37.0	37.4	37.0	14.8	13.6	14.8	13.6
Total, United States	1,733,939,000	1,856,107,000	4,750,518	5,085,225	1,730,197,000	1,852,246,000	4,740,266	5,074,647

* Production of 29 companies; refinery runs of 25 companies. † Net production of above companies (their net share) is here estimated as representing 87 percent of their gross production; and production for account of royalty and co-owner interests is estimated as 13 percent of gross.
‡ Humble Oil and Refining Company's data are included with those of Standard Oil Company (N.J.) and are not duplicated in totals.

keting branch. The figures stand out in contrast to similar ones for various other large industries, in some of which only a few companies account for large proportions of the operations.

United States production of crude oil in 1947 averaged 5,085,225,000 barrels daily, according to the U. S. Bureau of Mines. Of this amount, 3,205,476 barrels daily or 63 percent was accounted for by 29 leading companies. This is the indicated gross production of the 29 companies, assuming that their net production was about 87 percent of their gross production. By subtraction it is indicated that the remainder of the producing industry accounted for an aggregate production of 1,879,749 barrels daily in 1947 or 37 percent of the U. S. total.

Both the 29 leading companies and the rest of the industry produced more oil in 1947 than in 1946, and the increases were about proportional, though there was a slight decrease in the smaller concerns' percentage of the total. While the smaller companies boosted crude production to 1,879,749 barrels daily in 1947 from 1,776,665 daily in 1946, they accounted for 37 percent of the U. S. total in 1947 against 37.4 percent the year before. The change in percentage was so small it may not have had any definite significance. However, it may have reflected various adverse factors that now confront small producers, such as greatly increased operating costs, high taxes, and shortages of materials. With crude oil scarce, there has also been a strong market for producing properties and exceptional incentive for small producers to sell holdings to the large concerns.

In refining there has been a more pronounced shifting of operations out of the hands of smaller companies and into the hands of larger concerns. U. S. crude runs to stills averaged 5,074,647 barrels daily in 1947, government figures show. Of this total, 4,383,494 barrels per day or 86.4 percent was accounted for by 25 companies. The same companies in 1946 ran to stills 4,039,566 barrels daily or 85.2 percent of the U. S. total for that year. Subtraction of these figures from U. S. totals shows that the remainder of the refining industry ran to stills 691,153 barrels of crude per day in 1947, or 13.6 percent of the U. S. runs. This is a decrease from the previous year in actual runs as well as in percentage of the U. S. total for the smaller companies. In 1946 they had run to stills an aggregate of 700,700 barrels of crude per day or 14.8 percent of the U. S. total. The curtailment of operations by the smaller refiners in contrast with expansion by larger companies probably was due to various causes, including the exceptional scarcity of crude oil, shortage of transportation facilities, the high and forbidding costs of plant modernization and expansion, and high taxes.

Considered with understanding, this tabulation showing U. S. petroleum industry operations by companies is an eloquent justification of the free and competitive system under which the industry so far has operated. The table shows that the U. S. petroleum industry ranks foremost in the world not through the master-minding of political dictators or the schemes of men employing cartels or state monopolies but through the vision, hopes, and work of many plain business men concerned mainly with the prosaic purpose of making a living. The far-flung U. S. oil industry, providing American citizens more oil than has ever been used in any other country under any other system, is made up of many men with many qualifications and of vast amounts of capital pooled by hundreds of thousands of investors.

There is so much capital, responsibility, and work involved in providing the oil used in the United States that it is difficult to conceive of the job continuing to be done in any way except the way it is being done, under the free enterprise system. In this way, there is a wide division of the burden of supplying necessary capital; many minds attack and solve the problems that arise endlessly; and many companies and operators join in the doing of the great task expected of the industry. This record of remarkable achievement by a free, competitive American oil industry discredits

■ CONTINUED ON PAGE 48

Operating Problems of the Independent Gas Producer

By L. T. POTTER
Lone Star Gas Company, Dallas, Texas

THE POSITION of the independent gas producer has become more difficult in recent years, due to increased complexities of the business, increased costs and hazards of deeper drilling, and increase in government regulations and taxes.

However, there have been some advantages gained by independent producers, including better markets, and they remain a strong force in the industry.

Especially enviable has been the independent producer's record in prospecting and discovering new reserves. He has made this record through courage, resourcefulness, and flexibility of operation, the latter being his outstanding advantage.

Through these same attributes, the independent producer also can achieve satisfactory solutions to his current operating problems.

THE independent gas producer always has the problem of obtaining and retaining the technical and professional assistance which has become increasingly imperative in the modern petroleum producing business. He recognizes that to provide his staff with technical assistance is to entail obligations and responsibilities over and above the dollars and cents of current cost. He is inclined to improvise in this matter to the extent of undertaking to be his own technician in more than one technical field. It is a credit to independent producers as a group that they meet this problem with results that generally are good under the circumstances.

Financial Problem

The independent gas producer is confronted with a problem in connection with his financial matters. He is operating in a realm of the petroleum business which is most hazardous and he probably finds that to borrow necessary funds for his operations requires him to pledge greater security than that which might be required in any other line of activity. He may find also that the interest costs involved in obtaining such money are higher than might be expected in other lines of endeavor, and perhaps higher than those required of others in the same industry who have a broader basis of operation.

The independent producer is currently concerned with the shortage of materials, notably pipe and casing, and with the higher cost of such items when they are available. It is to be hoped, and perhaps it may be reasonably expected, that these shortages will not be a continuing proposition over a long period of time.

There is considerable information available to indicate that the independent producer who is concerned with natural gas operations, may have a problem arising from the question of whether he is to expect direct dealings with the Federal Power Commission in connection with natural gas regulatory powers.

One of the truly fundamental problems which confronts the independent producer is how he is to be affected by, and how he is to react to, the seemingly certain trend toward unit development and operation of individual petroleum reservoirs. There has been in the past a considerable natural opposition on the part of the independent producer toward cooperative arrangements in field operations. Many independent producers, however, have overcome this antipathy to a large degree, particularly with respect to secondary recovery operations. This has probably come about simply because the industry has learned that joint endeavor is effective and desirable, if not absolutely essential, in many operating circumstances. Joint or unit operations have proven themselves to be fundamentally sound and progressive, from the physical standpoint, and the trend is toward a situation under which there will be more and more such operations in the future.

When considered on an over-all basis with respect to any one reservoir, joint operations which are properly conceived appear to have overwhelming advantages both as a matter of development and operation. The objective of these arrangements should be one of the accomplishments of proper coordination of activities on a field-wide basis. It would be reasonable to expect that future evolution in the means and methods applied to development and operation in the fields will be along lines of permissive and voluntary unitization or joint arrangements. It is also reasonable to assume that in the absence of such evolution on the part of the industry there will come a time when desirable development and operating practices are achieved on a field-wide basis as a result of compulsion rather than of voluntary action.

Gas Proration

The subject of gas proration is one of interest to any independent producer and it certainly may be considered to be one of his problems in connection with his natural gas operations. The real fundamental problem in gas proration is of devising a rational basis for the

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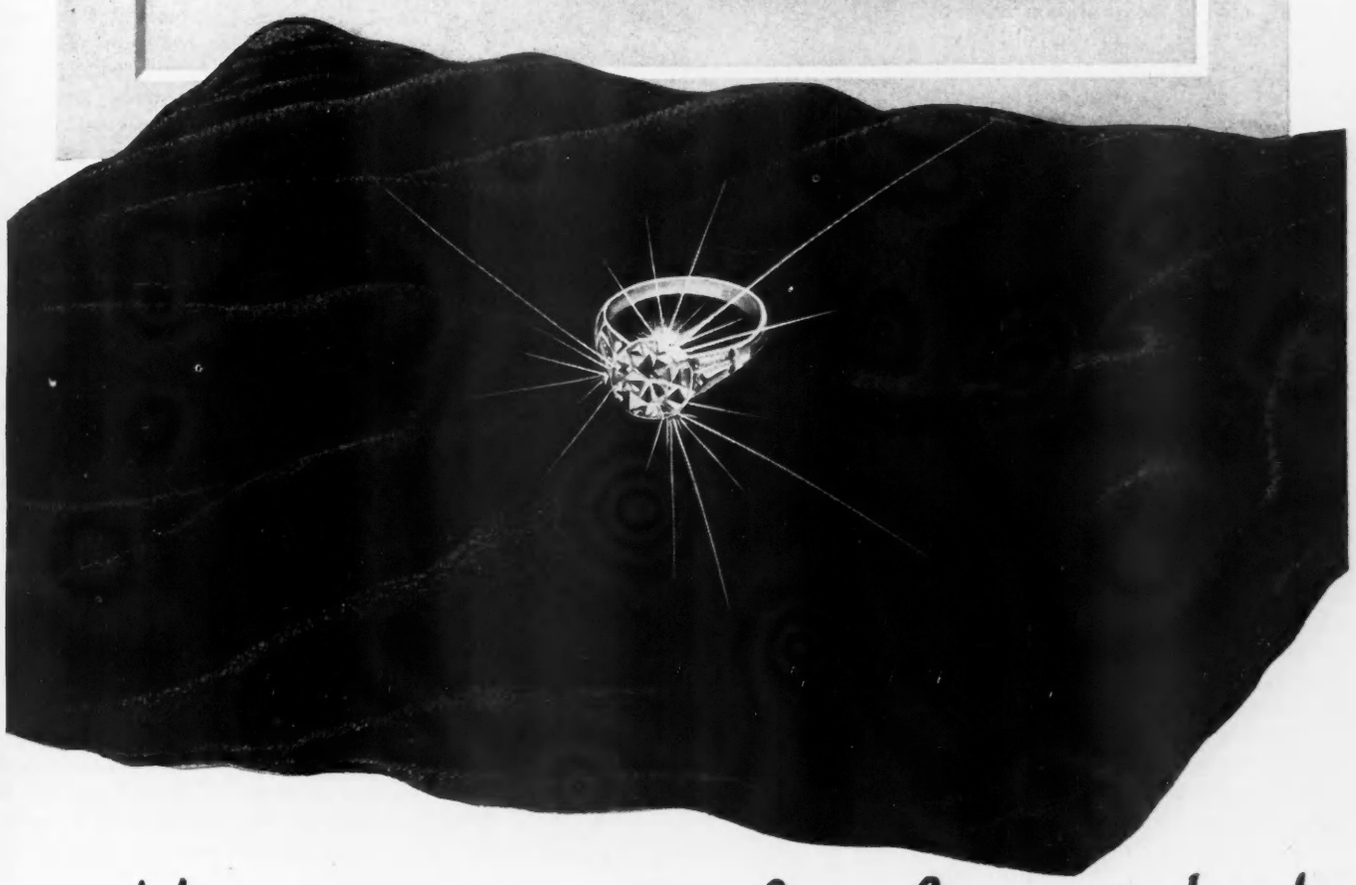

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attainment of two objectives which are seemingly in conflict in some cases. These two objectives may be stated as follows:

(1) To achieve the type of over-all development and operation which will be optimum from the standpoint of true conservation.

(2) To achieve the type of over-all development and operation which will reasonably protect property rights.

It is apparent to any student of gas proration matters that these two objectives are in conflict to some degree in any field where development and operation have proceeded on a pattern which happens not to fit proration requirements with respect to the two objectives. Specifically, it might be pointed out that the proper application of gas proration to the Panhandle field will be difficult because the pattern of development and operation which has been achieved long since in the field appears to be such as to cause conflict between the two fundamental objectives.

The problem of applying gas proration in a new field does not present nearly so many difficulties because the pattern of development and operation may be properly influenced by the application of suitable proration requirements. In this respect, however, there is one important fundamental consideration which frequently is overlooked. The particular gas proration formula which is to be applied to a new field should be designed so as to require the widest spacing of wells which is justified under the circumstances, to the end that the field will be fully developed. It is far better to space wells too widely in the early stages of development in a field in order to assure complete development than to space too closely at the risk of leaving portions of the field undeveloped.

There is another angle of this problem which also requires thoughtful attention. This is the matter of over-all ratable take from all wells in any reservoir which happens to produce oil and casinghead gas as well as dry gas. It should be admitted as a fundamental proposition that the regulation of ratable take of oil anad casinghead gas from wells in a field may not properly proceed on a basis which is entirely independent of the regulation of ratable take from gas wells in the same field.

Finally, with respect to gas proration, it should be realized that the fiction of state-wide proration, contrasted to proration within individual fields, is unrealistic in its conception and impossible to achieve. Economic and operating factors and conditions must provide markets for fields which are unconnected and should they not do so, state-wide proration could not be expected to accomplish the result. It is not intended to ignore the fundamental, physical considerations which render state-wide gas proration impossible of rational achievement but a full development of this matter is beyond the scope of this article.

About the Author

L. T. POTTER, assistant to the president of Lone Star Gas Company, is a native of Dallas. Upon graduating in 1928 from Texas A. & M. College with a Bachelor of Science degree in mechanical engineering he entered the employ of Lone Star. Until about a year ago he was engaged primarily in production work and was superintendent of production for several years prior to February 15, 1947, when he became assistant to the president.

Casinghead Gas Waste

It would be safe to say that at least two problems of major importance to the independent producer may be mentioned in the category indicated by the term casinghead gas. The first of these two problems is the one that is embodied in the waste of casinghead gas. In the considerable study which has been given to the problem of flared casinghead gas, an undue amount of emphasis has been placed upon the obligation of gas pipe lines to take this gas to prevent it from being wasted. There is an obligation resting on the gas pipe lines to take such gas and they should, in good faith and for the sake of their own self interest, utilize this gas to the fullest within the limits of practicability. There has been a tendency, however, in much of the conideration which has been given to the casinghead gas problem to overlook or to minimize the obligations of the producer with respect to the matter. It must be recognized that the producer at least shares a joint responsibility for the proper disposition of his casinghead gas.

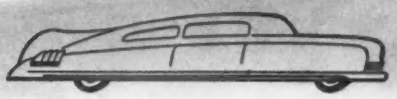
The preceding remarks about casinghead gas, it should be made clear, relate solely to the relative positions of the producer and of the pipe line transporter to the problem. There is a third party in the picture, so to speak, and he is the processor who handles casinghead gas for the extraction of liquefiable hydrocarbons. It is in connection with the processor that the second of the two problems arises for the independent producer in relation to casinghead gas. There is some indication that many independent producers would designate the casinghead gas purchase contract as one of his operating problems and would say that the usual contract of this nature is unfair to him as a producer.

This is a problem which may not be dismissed with casual coverage but a full discussion of the matter is beyond the limits imposed on this presentation. There are some observations about the matter, however, which may be made to indicate some of the fundamentals which are pertinent to the situation.

In the first place, it may be pointed out that the recent general improvement in economic conditions surrounding the realm occupied by casinghead gas purchase contracts, has reacted favorably for the independent producer. The increase in prices of liquid products has been reflected in his revenue from casinghead gas which is processed. More favorable markets for casinghead residue gas have been beneficial to the producer. In addition, the more favorable economic conditions presently existing will have the tendency to liberalize the terms of casinghead gas purchase contracts in favor of the producer. It appears that this result already has been achieved in some instances. Finally, these favorable circumstances may reasonably be expected to encourage the expansion of existing gasoline plant facilities and the construction of new facilities which are favorable to the producer.

It is also pertinent to this matter to remember that the processor of casinghead gas has not always had the benefit of favorable marketing conditions for his products of liquids and residue gas. It would probably be found that the processor, in the main, suffered along with the producer when the gasoline plant business was not so favorable as it now appears to be. It should be remembered also that individual casinghead gas purchase contracts result from negotiation between the producer and the processor just as contracts for the sale of residue gas results from negotiation between the processor and the purchaser. If some casinghead gas purchase contracts now seem to be unsatisfactory to the producer who entered into such contracts, so is it probably true that some contracts for the sale of residue gas now seem to be unsatisfactory to the processor. Except for variations injected as a result of good or bad trading, the terms of such contracts in the future will become more favorable or less so, dependent upon economic conditions influenced by demand.

Aside from these, general considerations, however, and in particular reference to the form of some casinghead gas purchase contracts, it already has been mentioned that under certain favorable



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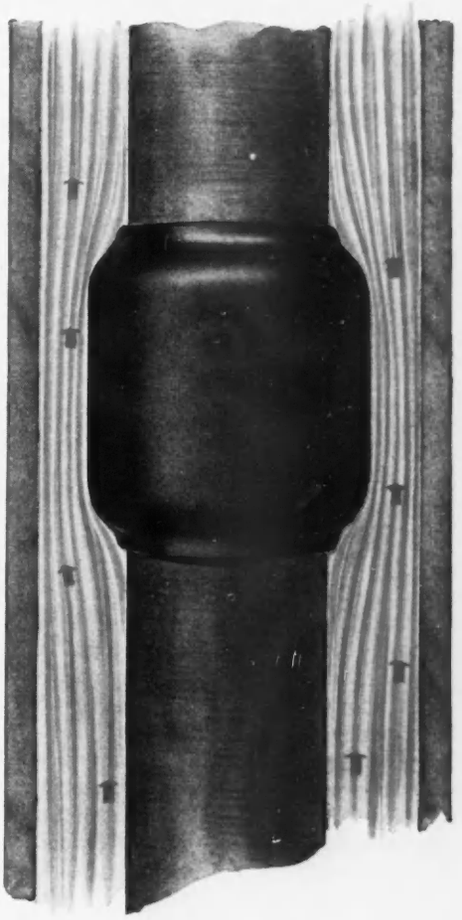

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conditions new forms of contracts are being utilized and it may be that some existing contracts are being revised to the benefit of the producer. It would seem to be certain that favorable economic conditions will operate to the advantage of the producer of casinghead gas in his relations with the processor of this gas.

It is easy to gather the impression that producers feel that they have a problem in connection with the mechanics and mathematics of the process of measuring the gas which they sell. There has been considerable agitation in favor of eliminating the practice of pipe line purchases being made upon the basis of a two-pound pressure base and there has likewise been a great deal of talk about making it mandatory that measurement include a correction for deviation from Boyle's Law. This matter is so pressing in the minds of some producers that legislation was suggested in one state that would make it mandatory and a legal requirement that a four-ounce pressure base and a correction for deviation be included in all purchase contracts and oil and gas leases.

Common Pressure Base

It must be admitted that the use throughout the industry of a common pressure base for measuring gas would simplify procedures to some degree, but in any event it is necessary that one dealing with gas should have an understanding of the physical considerations involved. He should know that if the price for 1000 cubic feet of gas on a pressure basis of two pounds above 14.4 is 6 cents, the equivalent price for the same gas on a pressure basis of four ounces above 14.4 is 5.3597 plus cents. He should realize that he could probably arrange to have in his contract whatever pressure basis of measurement he desires but that he could expect the price to be adjusted accordingly because price is controlled by economic consideration and not by physical definition.

Correction for deviation from Boyle's Law is rapidly becoming standard practice in cases where the gas is to be measured at pressures and under other conditions which would make the correction material.

Both of these contentions cancel out, however, when they are considered on the basis of what is really fundamental in the matter. It makes no basic difference what the definition of a cubic foot of gas may be for purposes of a contract, providing the parties to the contract understand their definition and its relation to price. It is probable that those who contend for changes in the method of definition of a cubic foot of gas for contract purposes, are actually hoping by such means to increase the price of gas. No one can blame them for trying but changes in economic conditions in relation to gas production, and only such changes, have brought about increases in prices for gas in the past and such must be the criterion for the future.

As a general proposition, there is considerable basis for the statement that the independent producer has a mutuality of interest with other segments of the petroleum industry, which is perhaps greater than most independents may realize. If this be true, it could be concluded that an existing problem is one of developing a greater recognition of this mutuality of interest. It would not be realistic to infer that the independent producer is the only one who should come to a greater realization of the common interest. The same necessity exists to a greater or lesser degree on the part of the natural gas pipe line segment of the industry, the processor of casinghead gas, the oil pipe line operator, the refiner, and the producer who is classified other than independent. It would be folly to suggest that the independent producer should be expected to abdicate his position or waive any of his rights merely because he has interests which are mutual with other groups in the industry. This he would not do and for the ultimate good of all concerned he should not do. But it is nevertheless true that some of the problems of the industry are made materially more difficult of solution because of a failure on the part of those concerned to recognize that a proper solution would be of mutual benefit.

Much has been said in recent years, particularly with the advent of the war and during the post war period, to the effect that the position of the independent producer has become more difficult and the fear is expressed that in due course of time the independent producer will not be able to maintain his position. It is true that the position of the independent producer has become more difficult in recent years, due to increased complexities of the business, increased costs and hazards involved in deeper drilling, and increase in governmental regulations and taxes. Notwithstanding these greater problems, however, the independent producer should not be "sold short."

The independent producer has made what is perhaps his most enviable record in the field of prospecting for new sources of petroleum supply. He has done so by using courage aand resourcefulness and by maintaining flexibility of operation, the latter of which is the principal advantage he enjoys in relation to others in the industry.

By the use of these same attributes, the independent producer can make a record in achieving solutions to his current operating problems which will be comparable to the record he has made in prospecting. The opportunities are attractive to the independent producer as he follows this course of action. To the extent that he does so, the industry, the country as a whole, and the independent producer himself will benefit.

U. S. Producing and Refining

• CONTINUED FROM PAGE 43

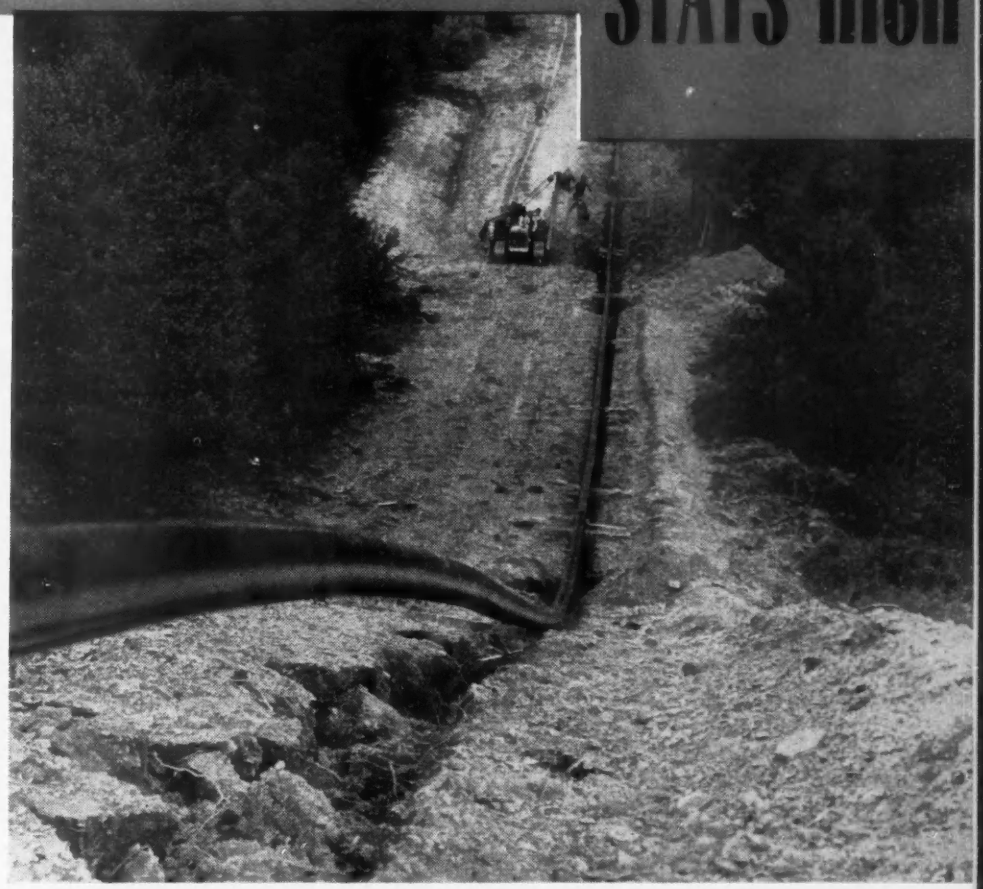
at once the idea of injecting government controls and regulations into the industry's affairs, as proposed repeatedly in the national capital.

Indicative of the wide distribution of crude oil production among U. S. producers is the fact that in 1947 the largest net share in the nation's total production was 7.8 percent, accounted for by the affiliates of Standard Oil Company (New Jersey), which had net production of 398,000 barrels daily. That same company's largest domestic subsidiary, Humble Oil & Refining Company, was outranked only by the parent concern, having reported net production of 343,200 barrels daily or 6.7 percent of the U. S. output. After those leaders came The Texas Company, with net domestic production of 245,895 barrels daily or 4.8 percent of the national total; Standard Oil Company of California with 244,646 barrels net domestic production per day or 4.8 percent of the U. S. total; and Gulf Oil Corporation with 216,116 barrels net production in the United States or 4.2 percent of the national total.

While the leading producers are integrated companies with large refining interests, they all produce less crude oil than their refinery requirements and therefore are large purchasers of crude from other producers. Standard Oil Company (New Jersey) ranks as No. 1 in refining as well as in production. Its domestic affiliates ran to stills 703,000 barrels per day of crude oil in 1947, which was 13.9 percent of U. S. runs to stills. Second largest refiner was Socony-Vacuum Oil Company, with refinery runs averaging 460,000 barrels daily or 9.1 percent of the U. S. total. Then came The Texas Company with runs of 381,039 barrels daily or 7.5 percent of the national total; Standard Oil Company (Indiana) with runs of 370,126 barrels per day or 7.3 percent of the U. S. total; and Gulf Oil Corporation with runs of 369,582 barrels daily or 7.3 percent of the national total.

More Pipe in Prospect

BUT DEMAND STAYS HIGH



By F. A. MARSH,

Assistant to Vice President, Sales
National Tube Company (U. S.
Steel Corp. Subsidiary)

THERE is a good possibility that 1948 will see a little more pipe produced than 1947, and the general outlook is not discouraging. It should be remembered that new plant construction and new plant improvements will be in evidence by summer or early fall. Also, the abnormal demand for some steel products, such as household appliances, seems to be easing, which may result in some improvement. Use of oxygen to increase steel production is being tried experimentally, and preliminary results are encouraging for future prospects.

Under the extremely acute conditions existing today, it has been impossible to meet all existing demands; yet in 1947 the pipe industry established a peacetime production record of approximately 6,400,000 tons of tubular goods, of which nearly 1,250,000 tons was line pipe. This would be an increase of 2,700,000 tons of total tubular production, or 73 percent over the average years of 1937-1940.

The gas industry is experiencing the greatest upswing in its history, but what is true of gas is also true of other industries, each of which feels it should have special consideration. Well over a million tons of trunk pipe lines per year will be required for the next four or five years, and along with this must go pipe for distribution lines and standard pipe connections. From all appearances, the reflected demand for pipe will continue strong at least for the next four or five years.

Line Pipe Demand

Major increases in pipe mill capacity cannot be accomplished within a short period of time, and unfortunately the sharp upswing in line pipe demand was paralleled by similar requests from other industries for other types of steel tubular products, leaving no unused facilities which might normally have been available for taking care of the increased line pipe load as had been customary in the past. Major steel plant equipment costs are enormous and to justify such expenditures all future demands must be carefully analyzed over a 20-year period or longer. It should be remembered, too, that pipe manufacturing facilities were driven to the utmost over the war years and have been kept in operation steadily since V-J Day with only emergency repairs, so any increase in production has been at great effort and cost.

Since 1930, the Steel Industry's ingot and casting capacity has risen steadily from 72 million tons until today it has reached a record figure in excess of 94 million tons per year. This increase has been fairly constant, but actual yearly production has fluctuated widely within the capacity limits.

Steel production has continued to be hampered by shortages of scrap, coal, coke, freight cars, natural gas, fuel, oil, etc. Work stoppages within the industry have caused the loss of more than 18 million tons of steel since V-J Day.

From a paper presented before the Public Utility Buyers Group, National Association of Purchasing Agents, March 8-9.

However, United States Steel produced over 28 million tons of steel ingots and castings during 1947, representing an average of 96.7 percent of capacity, and in the fourth quarter this figure reached 100.7 percent.

National Tube Company has continued to keep pace with this unprecedented production rate. In January, 1948, one of our major pipe manufacturing plants broke its existing records by shipping 52,729 tons of finished pipe ranging from 4½ inches to 24 inches in diameter, practically all of which went to companies engaged in the production and transportation of oil and gas.

Steel Expansion Program

The steel industry, as a whole, is engaged in a 1.7 billion dollar rehabilitation and expansion program, included in which is over ½ billion dollars for improvement and expansion of U. S. Steel Corporation's facilities. A substantial portion of this will be spent in the plants of National Tube Company to provide added facilities, such as revamped buttweld mills and galvanizing units, a new coke plant, new blooming, billet and bar mills, and a completely new warehouse for handling standard and miscellaneous pipe. Also we are building a new high-speed mill to produce 2-inch to 4-inch seamless pipe faster than any other mill we have. When this unit is ready, it should assist greatly in supplying small-size pipe. Unfortunately our construction program has been hampered by so many obstacles that it will be impossible to get the mill into operation before early 1949. In addition, we are rebuilding the large-size pipe mill at Lorain, Ohio, to facilitate manufacture of 26-inch O.D. seamless pipe. After completion of the building program, our capacity will be better balanced, and our production somewhat increased.

We are not familiar, of course, with detailed plans of other pipe producers, but little added capacity has been publicly announced, except for the two mills at Los Angeles, California, and Gadsden, Alabama, for manufacture of large diameter electric welded pipe used for gas and oil transportation systems. A new continuous buttweld mill has gone into operation on the Pacific Coast, and one is being built in the Pittsburgh District, which will improve the small buttweld pipe situation to some extent.

Gas Pipe Lines

Requirements for Utility Gas lines together with the trunk lines which must supply these systems contribute heavily to the greatest peace-time pipe demand in all history. It is difficult to keep abreast of all planned gas pipe line projects, but this figure is estimated by your association at approximately 20,992 miles, totaling 4,970,000 tons of large-diameter lines desired in the next five years.

Normally, tubular goods represent about 10 percent of the total semi-finished steel production. Preliminary figures from the American Iron and Steel Institute set tubular production at 6,117,000 tons in 1947. This figure may be raised to perhaps 6,400,000 tons when final year-end reports are collected. The latter figure compares with a final figure of 5,058,468 tons produced in 1946. Thus it is estimated that 1947 production was more than 26 percent greater than that of 1946. This figure may be roughly divided into 38 percent standard pipe, 12 percent mechanical and pressure tubing, 21 percent oil country goods, and 20 percent line pipe, with the balance going into lesser products. Traditionally about one-third of the trunk line pipe is used in construction of gas lines. Prior to the war in the 1936-1940 period, the oil and gas industry averaged 260,000 tons per year of trunk line tonnage, while present indications point to a demand of over 1,200,000 tons per year for the next four or five years. It is also necessary to recognize a complete change in the nature of these requirements in that sizes over 20 inches, which represented 17 percent of the pre-war demand, have now increased to approximately 72 percent of total gas line requirements. Therefore, line pipe manufacturers find themselves with a problem of supplying a demand for large diameter lines which is at least 20 times greater than anything previously experienced.

Allocation of Pipe

Late in 1945, it had become apparent that some form of allocation was necessary if tubular goods were to be channeled to areas and to customers who normally had a claim to them based on historical records. Distasteful as allocation is to all of us, it was the only fair basis on which to operate. On standard pipe, oil country goods, and miscellaneous line pipe this was comparatively simple for these items are purchased in fairly uniform quantities by regular buyers. In the case of large gas lines, an entirely different problem was presented, and because of intermittent purchases, size, quantities, etc., these materials had to be handled largely on a "first come, first served" basis with the producer endeavoring to serve as many customers as possible and to maintain a proper relation between oil and gas lines.

As a result of this action, our large line pipe order books are now filled well into 1952. But it should be borne in mind that this applies only to large trunk lines, as miscellaneous line pipe tonnages are being, and will continue to be, distributed to all districts on a historical basis.

While on the subject of availability of gas line pipe, it might be well to mention briefly some of the demand problems pipe manufacturers are facing from the closely related oil producing and refining industries. An average of several oil country forecasts indicates that in 1948 oil companies will drill approximately 35,700 wells, totaling in excess of 125 million feet of hole. These figures might be higher if an ample pipe supply were available. This represents an increase of 8.0 percent in wells and 10.7 percent in total footage over 1947. Use of crude oil and products lines has increased tremendously so that these elements are presenting their own supply problems.

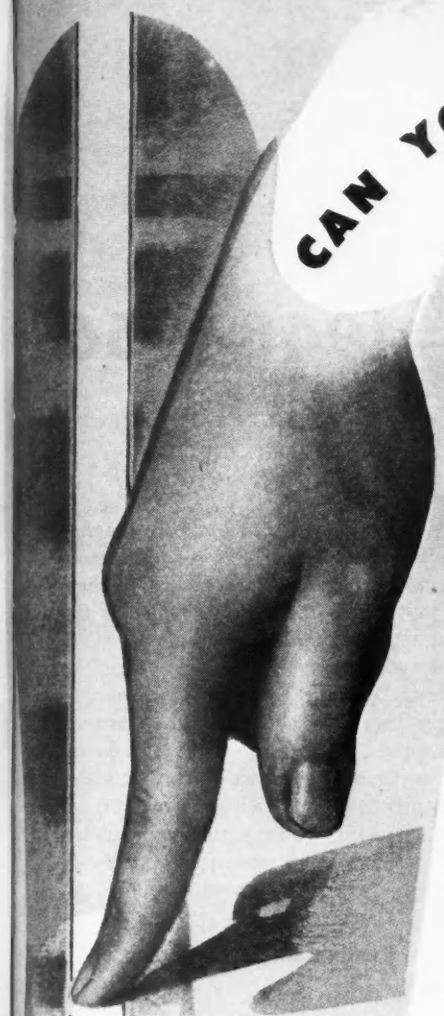
Fuel Oil Demand

Forty percent of the energy used in the United States is furnished by oil and gas, and the increase in use of these products has been phenomenal since the war's end. Everyone is aware of the acute fuel oil and gas shortages which developed in the Middle Western and Eastern States last winter, and there is every indication that gasoline will be short throughout the summer. In 1947, the United States used more oil and gas products than the remainder of the entire world previous to the war, all of which simply adds to increased pipe demand.

Considerable publicity has been given the so-called "gray market." No one is more interested in seeing these practices curbed than are the pipe manufacturers themselves. Allocation has gone a long way toward helping correct this situation, and we believe the total amount of pipe moving in this manner is relatively small. Our company has long since adopted a policy of refusing to sell any customer known to have allowed materials to stray into hands of those accused of "gray market" practices.

Many questions have been raised and much comment offered regarding the quantities of pipe shipped in export. The American Iron and Steel Institute reports that manufacturers of steel pipe exported approximately 7 percent of their production during the years 1937-40. The percentage of total pipe exported by Institute members in 1946 was 6.7 percent, which is exactly the same as for the first 11 months of 1947.

Practically all of National Tube Company pipe shipped in export is sold to American-owned companies, and furthermore, all sales are subject to allocation on exactly the same basis as that being followed for domestic customers. As yet there are no definite indications regarding requirements of the Marshall Plan for European Recovery. At present, all exports are under the control of the Department of Commerce, who are empowered to issue the export permits.



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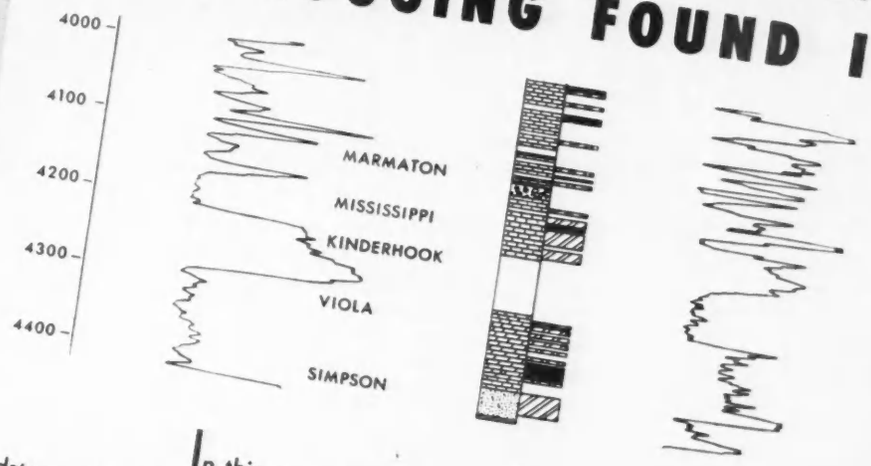

In this area, the principal oil producing strata is the Simpson sandstone, directly above which is the gas-producing Viola lime, with no shale break between. To locate and define the formations, and to indicate zones of porosity, Lane-Wells ran a Combination Log: the contact between the Simpson and the Viola, barely discernible on the Gamma Ray Curve, is clearly marked on the Neutron Curve. Dual completion was based on the log, and both zones gun perforated. Initial potential of this well is 10 MCF gas from the Viola, 3,000 BOPD from the Simpson.

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The Imbalance Factor in

WORLD SUPPLY-DEMAND PROSPECTS

1948-1956

By HENRY OZANNE
Staff Writer

ONE of the most comprehensive studies yet made of the petroleum demand and supply prospect on a worldwide scale has been completed by Socony-Vacuum Oil Company, Inc. The results of this survey, which cover the period 1948-1951 and 1956, were summarized by A. J. McIntosh, the company's economist, for WORLD OIL.

McIntosh's approach to the problem is different from that presented in the first article in this series. In the preceding analysis the emphasis was on *balance*—attempt was made to reconcile "supply" and "demand" to show the convergence of these two sets of figures. The Socony-Vacuum study, on the other hand, approaches "supply" and "demand" as separate problems, without concern for balancing them out. In fact, it is *imbalance* which is the object of McIntosh's attention; and in this way he arrives at an "overage" or "underage" which represents the narrow margin between "supply" and "demand" and delimits the area in which the industry may exercise free choice in such matters as augmenting or reducing imports or exports, changing refinery runs by building additional refineries, modifying yields or adjusting them to increased consumer demand.

This is the second in a series of articles dealing with worldwide petroleum supply and demand forecasts. The first appeared in WORLD OIL for April, 1948.

TABLE 1

(USSR and satellites excluded. Figures predicated on downward revision of the original U.S. State Department estimate of requirements for Marshall Plan countries)

Thous. 42's daily

WORLD CRUDE AND ALLIED PRODUCTS PRODUCTION

AREA	1948	1949	1950	1951	1956
U. S. A.	5806	5975	6148	6328	7185
Other Countries	3075	3415	3722	4057	4658
World Total	8881	9390	9870	10385	11843

WORLD DEMAND
(Not Limited by Refinery Capacity or Tankers)

AREA	1948	1949	1950	1951	1956
U. S. A.	5795	5950	6150	6350	7380
Other Countries	2842	3053	3245	3435	4128
World Total	8637	9003	9395	9785	11503

WORLD SURPLUS

AREA	1948	1949	1950	1951	1956
U. S. A.	11	25	—2	—22	—195
Other Countries	233	362	477	622	535
World Total	244	387	475	600	340

TABLE 2

Reconciliation of Runs to Stills with Demand
In thousands of barrels a day

	1948	1949	1950	1951	1956
Demand (Table 1)	8637	9003	9395	9785	11503
Production Natural; etc.	407	435	463	488	613
Fuel and Loss Not Run	213	175	180	190	200
Total demand supplied from sources other than refineries	620	610	643	678	813
Refinery Runs Required to Meet Demands	8017	8393	8752	9107	10690
Stock Building	86		(Not Estimated)		
	8103				

Enough Raw Materials

Four questions put to McIntosh and his answers to the over-all queries are as follows:

(1) Q—Will there be enough raw materials (crude and allied products) during the forecast period to supply the anticipated demands?

A—Any limitation on meeting full world demand will not stem from insufficient supplies of raw materials.

(2) Q—Will there be sufficient refinery capacity in the world to meet the demand forecast?

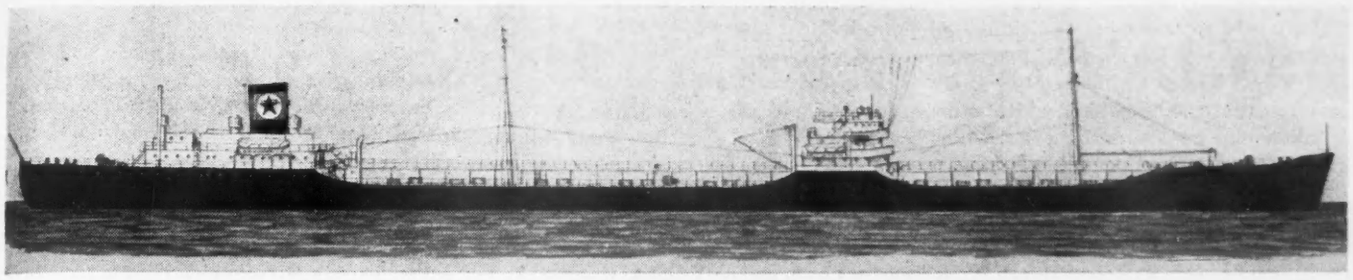
A—In the U. S. (and I am including what is building and planned) capacity seems sufficient through 1950 or 1951. After that it appears that a building program at an average rate of something around 150,000 barrels a day per year will have to be undertaken to meet 1956 demands. In foreign countries capacities are insufficient throughout the entire period.

(3) Q—Will there be any bottleneck in the pipe line capacities in the world?

A—These will be sufficient if building programs are completed as they are now scheduled.

(4) Q—Will there be enough tankers in the world to transport the estimated quantities of crude oil and products which are to be moved between producing and consuming areas?

A—Tankers, generally, will be suffi-



Architect's drawing of a new Texaco tanker, four of which are to be built for The Texas Company by the Bethlehem Steel Company, Shipbuilding Division, Quincy, Mass. These oil tank vessels will be among the largest in the world. The first ship will be in service about July, 1949, the other three following along shortly thereafter. Each vessel will have an over-all length of 623 feet, beam of 84 feet, displacement of 36,250 tons, and capacity of 240,000 barrels.

cient provided some overage tankers are retained in use. This is indicated in Table 6.

Likely Demand

In elaboration of his reply to Question 1, that crude oil supplies will be sufficient, McIntosh offers Table 1, in connection with which he points out that a conclusion from the figures is that the demand forecast may be exceeded in the U. S., where refinery capacity seems to be available, but that foreign crude may not be produced to the extent possible because of other limiting factors. "In actual practice of course," he adds, "the two sets of figures will balance except for stock changes."

In extending his answer to Question 2, McIntosh said:

"To meet the demand we would have to run to stills the quantities shown in Table 2 which sets forth how much of the demand would be met by crude oil direct sales and natural gas liquids. Comparing the results with capacities, we find from Table 3 that there appears to be enough U. S. refinery capacity, including those plants listed for completion during 1948 and 1949, to take care of estimated runs to stills into 1950 or 1951. Undoubtedly it will be necessary for individual companies to increase their capacities after 1949. This should raise the industry's ability to refine more in the latter years. These building programs would have to be at the rate of about 150,000 barrels per day for each year, beginning after 1949-1950 through 1956 to provide another 700,000 barrels capacity by 1956.

Foreign Refinery Capacities

"Looking now at the foreign refinery capacities, there does not seem to be sufficient capacity in any year to care for required runs to stills. There is also the question whether the contemplated increases in refining capacities used in the foreign section actually will materialize. There is a possibility that some of the foreign crude could be sent to the U. S. for processing, for re-export as products. For the next couple of years there appears to be sufficient refining capacity in the U. S. to allow for this, if tankers are available."

In detailing his answer to Question 3, McIntosh said:

"New pipe line construction in the U. S. would, of course, have to provide gathering and trunk lines for new production, as indicated in Table 1. This new construction usually goes on year after year. Some trunk lines, however, will have to extend into the Midwest. Lines that are now under construction or planned, into the Midwest, should relieve the situation greatly. California might require new lines from the Rocky Mountain area or Texas, based on crude production and demands, even though Persian Gulf oil is imported. The announced increase in capacity of the Portland pipe line will reduce tanker requirements but will not increase supplies. We assume foreign pipe lines have been operating as shown in Table 4. These capacities have been used to calculate the probable crude production in the areas."

In explaining his answer to Question 4, McIntosh said:

"There appear to be enough tankers

TABLE 3

Comparison of Refinery Capacities and Required Runs to Stills

(Predicated on downward revised U. S. State Department estimates, February 6, 1948, of requirements of Marshall Plan Countries).

World—Excluding USSR and Satellites (In Thousands of Barrels)

	REFINERY CAPACITIES				
	1948	1949	1950	1951	1956
U. S. on 100 percent Basis	5800	5975	6100*	6140*	6180*
Other Countries	2681	2878	3192	3506	3910
World Total	8481	8853	9292	9646	10090
Refinery Runs to Stills Needed to Supply Demand	8017	8393	8752	9107	10690
Capacity Over Runs Needed	464	460	540	539	....
Capacity Short of Runs Needed	....	....	....	....	600
Percent Over or Short on U.S. at 100 percent	+6	+5	+6	+6	—6
Percent Over or Short on U.S. at 95 percent	+20	+20	+3	+3	—9

* No building programs announced beyond 1949, but more of capacity in Rocky Mountain area and California utilized. Undoubtedly more capacity will be built and 1956 deficit should therefore be eliminated.

TABLE 4

Estimated Foreign Pipe Lines to be Constructed

Very Tentative

(Barrels 42's)

Area and Pipe Line	Size	Completion Date	Approximate B/D Throughput
Middle East Area:			
Kirkuk to Haifa (I.P.C.)	16"	1- 1-49	87,500
Saudi-Arabia to Sidon (Tapline)	31/30"	1- 1-50*	330,000
Kirkuk to Tripoli (I.P.C.)	16"	4- 1-50	87,500
Kirkuk to Tripoli (I.P.C.)	30"	1- 1-53	300,000
Iran-Syria (Middle East P. L. Co.)	36/34"	(1956 or	420,000†
Kuwait-Eastern Medit. (Gulf-Shell)	36/34" Est.	Earlier)	200,000
Qatar (Persian Gulf)	12"	.....	42,000
Basrah (Persian Gulf)	8/10" Est.	.....	21,000
South America—Venezuela:			
Mercedes to Port LaCruz (Texas Co.)	16"	11- 1-48	100,000
L. Maracaibo to Is. of Paraguana (S.O.N.J.)	26/24"	1- 1-49 to 7- 1-49	Not Known

* Due to stoppages, this date probably will not be met. † May be 500,000 barrels per day by 1956.

The above pipe lines under construction are the major ones which will aid in world crude oil availability and transportation.

in the world to transport the estimated international and intercoastal quantities, but I would like to emphasize that there are important qualifications which must be taken into consideration with details presented in Tables 5 and 6.

"Tanker requirements for each year have been arrived at by detailed analysis of the quantities and various trades in which water-borne transportation is involved—consistent, of course, with the availability of supplies from foreign refineries operated at stated capacities and estimated normal U. S. imports and exports. Generally speaking, a short-haul basis was used. In calculating tonnage efficiency, the T-2 type tanker has been used and voyage figures were made based on 18 ports of loading and 34 areas of discharge with various combinations of each.

"For tanker availability, a basis figure as of January 1, 1948, of 1005 T-2 equivalents was used. This figure was developed by the Committee on Petroleum Tanker Transportation of the National Petroleum Council and agreed on by all its members in mid-November of last year. They estimated that there was a world tanker fleet in existence then of 1271 T-2 equivalents, but 266 were deducted — some because they were engaged in strictly military service of different governments and some for various other reasons. To this basic figure has been added new construction on these assumptions:

"1. That of each year's original forecast of deliveries from foreign yards, 40 percent would be delayed into the subsequent year.

"2. That estimates of deliveries from domestic yards would be as contracted.

"3. That, based on the calculation that of the aggregate tonnage delivered each year, 50 percent would be available for the entire year—to allow for a normal staggering of deliveries.

"No allowance for obsolescence has been made except in memorandum form on the tonnage statement, since there is no hard and fast rule to be applied. Ordinarily 20 years is a conservative estimate of the life of a tanker, but today, of course, this is being greatly extended through costly rehabilitation.

TABLE 5

International and U. S. Coastal Movements of Crude Oil and Finished Products Via Tanker*

1938, 1948 — 1951 & 1956

(1000's Bbls. 42's Daily)

	1938	1948	1949	1950	1951	1956
International:						
Within the Western Hemisphere	435	856	901	964	1046	1072
Western Hemisphere to Eastern Hemisphere (West of Suez)	625	497	435	439	487	279
Western Hemisphere to Eastern Hemisphere (East of Suez)	136	28	39	32	29	9
Within the Eastern Hemisphere (East of Suez)	150	535	556	588	600	677
Persian Gulf Westward	116	450	527	467	428	102
Eastern Mediterranean Westward	85	112	157	507	681	1155
Black Sea to Europe and Africa	96	....	....	....	....	....
Far East Westward	8	....	....	....	....	....
Far East Eastward	2	....	....	....	....	....
Total International Thous. of Bbls. per Day	1732	2478	2615	2997	3271	3294
Billions of Bbls.—Miles Annually	2160	3416	3670	3897	4150	3870
Index No. (Based on 1948)	63	100	107	114	121	113
U. S. Coastal Movements:						
Gulf Coast to East Coast	985	1486	1530	1580	1630	1795
California to East Coast	15	†	....	....	....	....
Pacific Coast Coastwise	215	355	366	378	390	430
Total U.S. Coastal—Thous. of Bbls. per Day	1215	1841	1896	1958	2020	2225
Billions of Bbls.—Miles Annually	753	1109	1139	1176	1213	1340
Index No. (Based on 1948)	68	100	103	106	109	121
Total World—Thous. of Bbls. per Day	2947	4319	4511	4955	5291	5519
Billions of Bbls.—Miles Annually	2913	4525	4809	5073	5363	5210
Index No. (Based on 1948)	64	100	106	112	119	115

* Excluding relatively small international movements of lubricating oils and asphalt that are shipped by tanker.
† Some movements being made now because of emergency conditions.

TABLE 6

World Tanker Requirements vs. Availability

(In Tankers of T-2 Capacity)

	1948	1949	1950	1951	1956
Tankers Required—International:					
Within the Western Hemisphere	156.9	163.2	177.2	192.2	205.4
Western Hemisphere to Eastern Hemisphere (West of Suez)	142.7	125.3	124.3	1398.1	76.8
Western Hemisphere to Eastern Hemisphere (East of Suez)	6.7	12.6	7.6	5.6	0.1
Within the Eastern Hemisphere (East of Suez)	148.9	147.9	157.4	157.7	179.9
Persian Gulf Westward	169.9	211.4	180.8	161.4	33.6
Eastern Mediterranean Westward	11.1	20.4	84.1	119.8	222.0
Total International	636.2	680.8	731.4	774.8	717.8
Index No. (Based on 1948)	100	107	115	122	113
U. S. Coastal:					
Gulf Coast to East Coast	224.8	230.8	238.4	245.9	271.6
Pacific Coast Coastwise	26.8	27.5	28.4	29.3	32.4
Total U. S. Coastal	251.6	258.3	266.8	275.2	304.0
Index No. (Based on 1948)	100	102	106	109	121
Total World Movements	887.8	939.1	998.2	1050.0	1021.8
Index No. (Based on 1948)	100	106	112	118	115
Tankers Available	1026.4	1075.6	1145.2	1208.9	1264.2
Over or Short	+138.6	+136.5	+147.0	+158.9	+242.4
Tankers 20 Years Old on 1-1-48	125	125	125	125	125
Tankers which will become 20 Years Old during Period	14	28	42	56	125
Total 20 Year Old Tankers	139	153	167	181	250
Over or Short after Deducting 20 Year Old Tankers	—0.4	—16.5	—20.0	—22.1	—7.6

Declining Tonnage

"From Table 6 it is seen that approximately 125 T-2 equivalents are presently over 20 years old and another 125 will fall into this category between 1948 and 1956. With this in mind, the tonnage status as shown for each year must be viewed with reservations, particularly in later years, say, from 1950 on. Also, consideration must be given the fact that some indeterminate number of the overage ships will not be available and the long tonnage position correspondingly reduced.

"Besides this, demand has been based on an average for the year and no consideration given seasonal fluctuations. It is difficult to calculate accurately this factor, but probably a 5 percent increase over the average for the peak season and a 5 percent under for the slack season are fair.

"Our studies seem to indicate that extraordinary shipments of crude oil might be made to the U. S. from the Persian Gulf because of the shortness of foreign refining capacity. This would make it possible to increase domestic demand still further and also provide larger than normal exports to foreign markets which otherwise would not be able to obtain minimum requirements."

The UNIBOLT WING VALVE

Dependable

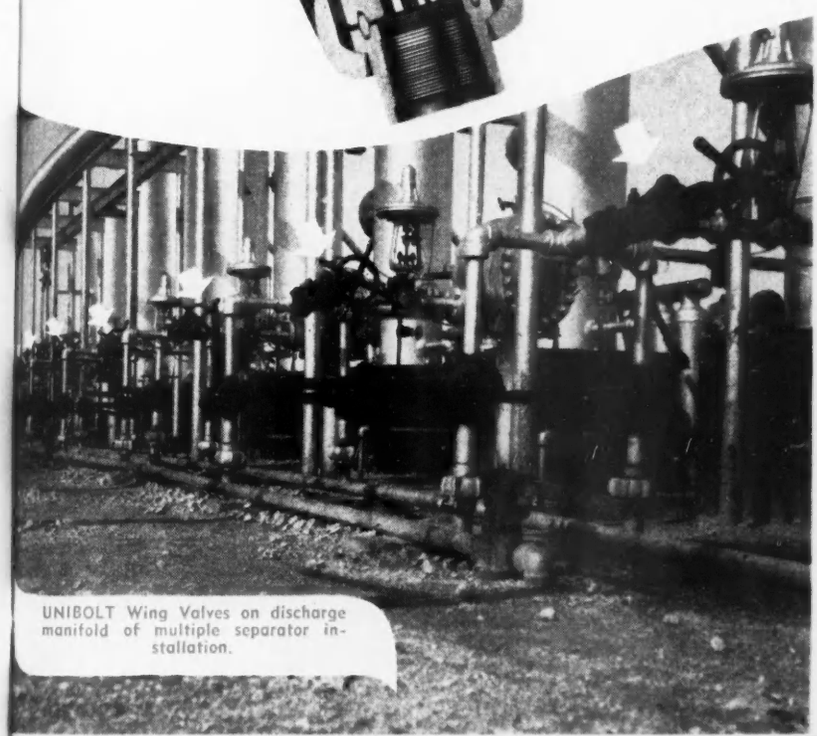
Although a pressure-tight shut-off is desirable in any service, there are a number of valve applications on lines handling high pressure oil and gas where dependable operation is absolutely essential. High pressure oil and gas separator manifolds, heater manifolds, meter runs, Christmas tree manifolds for producing and injection wells, are a few instances where the valve is frequently put to a critical test. A valve failure at these points could result in extremely costly and hazardous remedial operations.

Because they are utterly dependable — easy to operate under all conditions and may be relied upon to effect a pressure-tight shut-off—UNIBOLT Wing Valves are ideal for such tough assignments. They are inexpensive, simple and economical to maintain because of easily renewable and interchangeable parts, and are available in conventional sizes in pressures up to 15,000 lbs. test. For unusually abrasive conditions or corrosive fluids, they are offered with hard chrome stems and seats and in high chrome corrosion-resistant alloy.

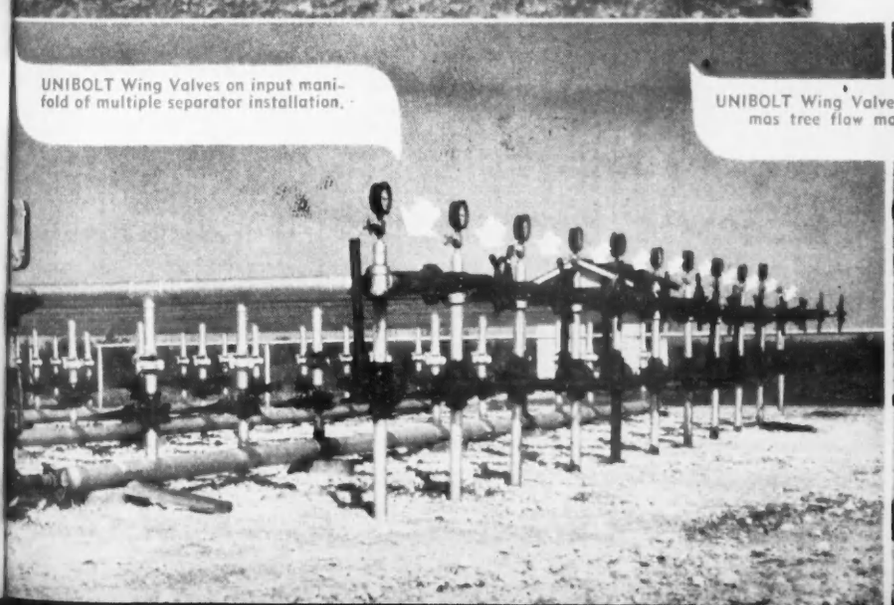
See your Composite Catalog for complete details or literature will be sent on request.

THORNHILL-CRAVER COMPANY

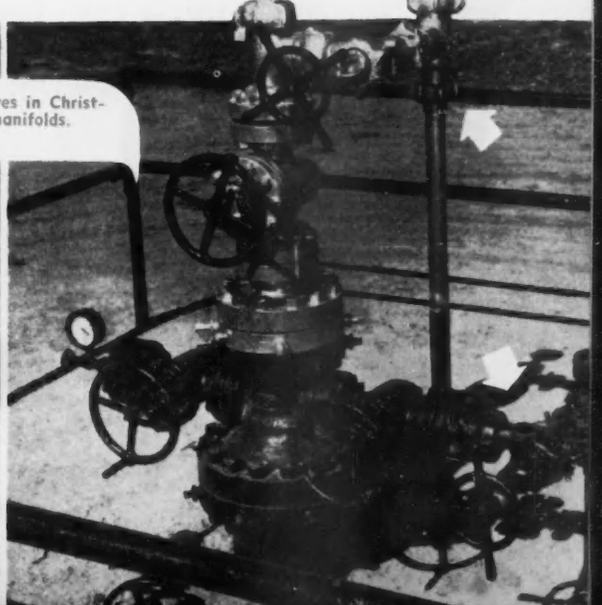
HOUSTON, UNIBOLT THE ONE BOLT COUPLING TEXAS



UNIBOLT Wing Valves on discharge manifold of multiple separator installation.



UNIBOLT Wing Valves on input manifold of multiple separator installation.



UNIBOLT Wing Valves in Christmas tree flow manifolds.

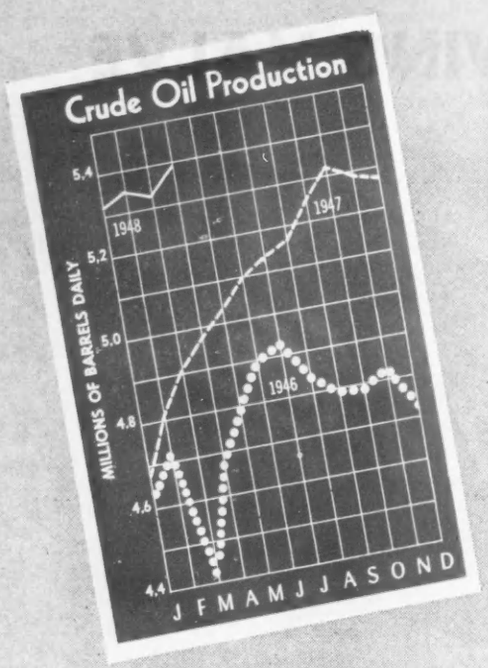
April Processing Follows

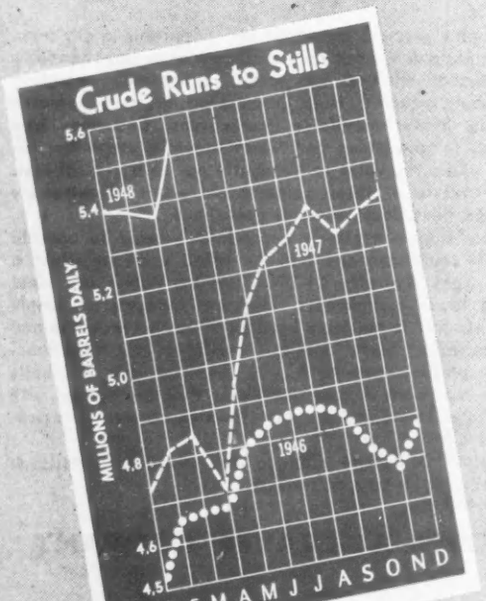
By CECIL SMITH

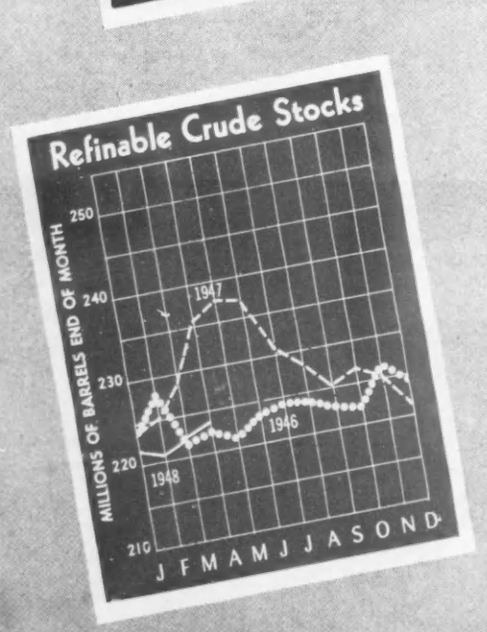
APRIL took its place at the head of a long line of record-breaking months for the petroleum industry's operations. It now stands at the head because it is the latest period for which statistics are available and it will hold this position only until the following month's are in. The trend of new all-time highs in crude production and refining with each new month started about a year ago when field output and refinery throughput first reached the five million-barrels-a-day mark and has continued almost uninterrupted to the present. As proof that the industry's very fine operating record during April was not yet its maximum were reports for the first half of May showing substantial gains in both producing and processing.

During April the nation's producers pushed daily output to the all-time peak of 5,398,000 barrels, 80,000 barrels per day over the previous month's average and 424,000 daily more than was produced a year earlier. This production rise from last year was creditable to the majority of producing states. While the larger portion of the hike was supplied by the major producing areas, most of the lesser ones were able to contribute to the all-out battle of supplying the nation's increased needs. Texas, Louisiana, Oklahoma, New Mexico, Mississippi and California led the parade of gainers and smaller increases in other states offset drops in Pennsylvania, Illinois, Kentucky and Montana.

Refiners continued to crowd their facilities during the month and succeeded in processing crude oil at the record rate of 5,536,000 barrels a day. This was also a new all-time high in runs to stills and exceeded the







Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1945:									
January	4,756	4,680	221,737	2,094	91,666	663	31,695	1,350	44,347
February	4,767	4,817	220,221	2,194	97,457	724	27,210	1,326	39,760
March	4,804	4,719	223,988	2,124	97,447	675	26,729	1,273	35,451
April	4,807	4,774	224,229	2,127	90,804	681	29,148	1,289	34,418
May	4,887	4,913	223,151	2,179	88,530	708	29,511	1,341	34,333
June	4,859	4,989	218,218	2,166	86,128	730	32,440	1,351	35,606
July	4,897	5,001	216,638	2,281	85,582	713	36,276	1,351	38,341
August	4,870	4,928	215,135	2,269	84,003	701	41,245	1,329	42,227
September	4,423	4,275	220,319	1,933	74,574	640	45,059	1,139	42,822
October	4,284	4,244	221,246	1,888	76,805	613	45,479	1,176	42,068
November	4,517	4,624	218,916	2,156	86,540	665	44,562	1,265	41,322
December	4,472	4,574	218,763	2,056	97,676	683	35,778	1,245	37,158
1946:									
January	4,625	4,520	223,442	1,914	102,394	787	28,990	1,224	34,573
February	4,719	4,651	227,220	1,884	104,836	823	25,511	1,243	34,008
March	4,414	4,661	221,400	1,900	104,161	816	29,922	1,213	32,995
April	4,673	4,663	222,480	1,943	98,744	773	32,064	1,247	35,206
May	4,785	4,794	221,592	2,016	93,960	753	33,385	1,220	38,932
June	4,896	4,836	223,140	2,055	91,971	777	38,824	1,219	41,492
July	4,922	4,856	224,351	2,102	87,778	793	46,439	1,163	45,446
August	4,836	4,856	224,157	2,189	86,745	765	54,068	1,159	48,186
September	4,790	4,839	222,417	2,143	87,021	796	62,019	1,150	54,012
October	4,785	4,736	222,177	2,117	85,952	788	76,780	1,090	55,580
November	4,823	4,684	226,453	2,162	88,587	791	68,145	1,101	52,735
December	4,725	4,780	224,473	2,168	92,742	805	59,912	1,159	47,094
1947:									
January	4,671	4,739	223,848	2,078	99,623	778	48,197	1,174	41,550
February	4,810	4,820	225,121	2,089	103,672	777	36,901	1,228	48,480
March	4,908	4,843	228,981	2,076	105,679	825	31,423	1,222	37,403
April	4,974	4,707	235,710	2,037	101,724	764	30,268	1,148	36,455
May	5,033	4,947	237,768	2,128	95,209	805	34,279	1,204	39,992
June	5,099	5,120	237,278	2,258	89,774	807	39,676	1,233	43,515
July	5,137	5,221	230,974	2,302	86,003	847	46,444	1,244	47,600
August	5,173	5,260	228,523	2,383	85,849	869	54,707	1,245	51,334
September	5,251	5,236	225,258	2,375	84,360	911	59,764	1,237	52,578
October	5,320	5,253	226,666	2,371	82,584	938	63,252	1,260	52,502
November	5,291	5,291	225,462	2,332	87,551	942	61,334	1,245	52,455
December	5,337	5,350	224,929	2,347	92,303	992	51,081	1,282	47,091
1948:									
January	5,283	5,348	223,430	2,328	102,167	1,082	41,036	1,278	44,636
February	5,353	5,380	224,880	2,264	110,999	1,127	34,590	1,295	43,156
March	5,318	5,364	222,930	2,235	113,300	1,082	31,553	1,284	41,485
April	5,398	5,536	222,944	2,359	111,560	1,018	35,083	1,290	43,605
April, 1948 Changes:									
In Month	+80	+172	+14	+124	−1,740	−64	+3,530	+6	+2,120
In One Year	+424	+829	−12,766	+322	+9,836	+254	+4,815	+142	+7,150
In Two Years	+725	+873	+464	+416	+12,816	+245	+3,019	+43	+8,399

Trends

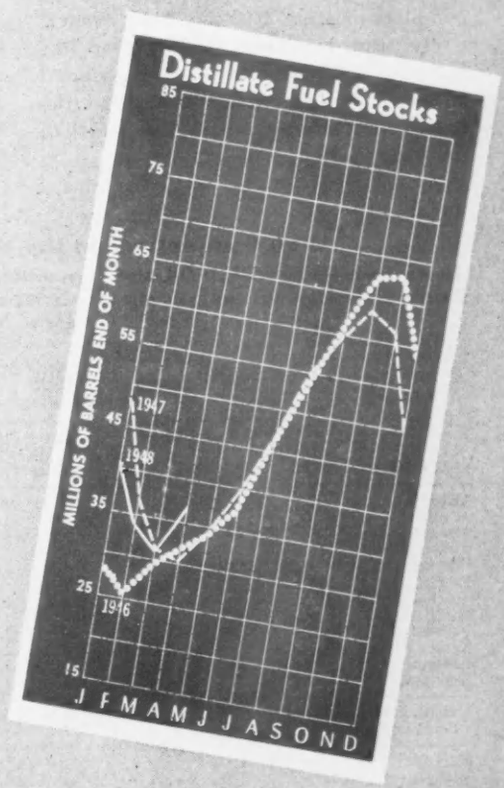
Up-Trend to Another High

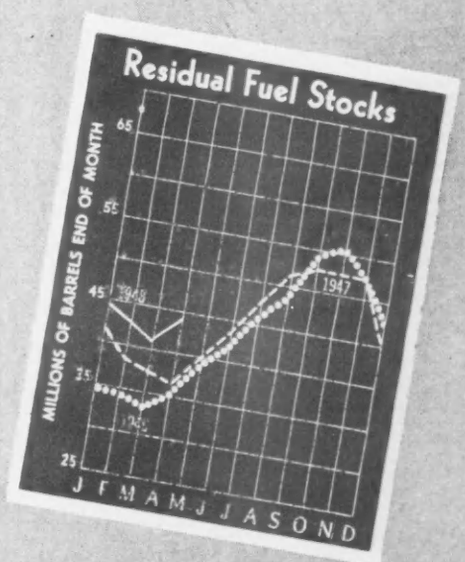
Staff Writer

previous month's by 172,000 barrels daily and those of a year ago by 829,000 barrels. In order to process April's crude the nation's refineries had to operate at about 95 percent of their total rated capacities, which is a very high rate of operation and very difficult to maintain for any sustained length of time. Of course, this capacity is being increased as steel becomes available for modernization of old equipment and construction of new facilities.

The accompanying table clearly shows that more crude was refined than was produced during the month, with the difference being made up by imports. These imports have been coming principally from South America, but shipments from the Middle East are increasing. Several of the major companies are bringing in this Eastern crude, with Socony-Vacuum recently announcing the arrival of their millionth barrel. April's total supply of crude, domestic production and imports, was only slightly more than the amount refined, and this is reflected by the very small increase in inventories of refinable crude oil. At the end of the month these stocks totaled 222,944,000 barrels, a gain of only 14,000 barrels during the period. These stocks were 12,766,000 barrels less than they were a year ago and about 43,000,000 barrels less than were available April, 1941.

In an attempt to keep gasoline production in step with mounting consumption, daily output averaged 2,359,000 barrels during April for an increase of 124,000 barrels a day over the previous month and 322,000 barrels over a year ago. Despite this hike in production, stocks of finished and unfinished gasoline were reduced by 1,740,000 barrels and ended the month at 111,560,000 barrels. That amount was still 9,836,000 barrels more than was on hand a year ago. Spring harvesting requirements started to make considerable inroads in these motor fuel stocks along with the starting of the heavy motoring season that will continue to step up until fall.





State Crude Oil Production

(THOUSANDS OF BARRELS)

STATE OR DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL FIRST FOUR MONTHS		
	April, 1948	March, 1948	April, 1947	% Diff. April '47-'48	1948	1947	% Diff. '47-'48
Alabama	1.1	1.3	0.7	+ 57.1	152	110	+ 38.2
Arkansas	82.1	80.7	79.4	+ 3.4	10,091	9,624	+ 4.9
California	941.8	939.6	906.3	+ 3.9	113,314	107,842	+ 5.1
Colorado	45.6	45.5	38.8	+ 17.5	5,484	4,512	+ 21.5
Florida	0.8	0.8	0.5	+ 60.0	96	47	+104.3
Illinois	172.6	170.6	186.3	— 7.4	20,845	22,651	— 8.0
Indiana	19.5	17.8	17.4	+ 12.1	1,979	2,068	— 4.3
Kansas	295.6	247.0	287.7	+ 2.7	33,803	33,243	+ 1.7
Kentucky	24.6	25.0	26.2	— 6.1	2,925	3,040	— 3.8
Louisiana	463.7	461.8	428.6	+ 8.2	56,607	50,524	+ 12.0
North Louisiana	109.3	108.1	99.4	+ 10.0	13,408	11,671	+ 14.9
South Louisiana	354.4	353.7	329.2	+ 7.7	43,199	38,853	+ 11.2
Michigan	44.9	45.1	43.4	+ 3.5	5,454	5,120	+ 6.5
Mississippi	121.1	118.8	87.1	+ 39.0	14,258	10,340	+ 37.9
Missouri	0.2	0.2	0.2	.....	20	18	+ 11.1
Montana	23.2	24.2	23.9	— 2.9	2,874	2,725	+ 5.5
Nebraska	0.5	0.4	0.6	— 16.7	61	76	— 19.7
New Mexico	128.1	129.3	106.7	+ 20.1	15,403	12,620	+ 22.1
New York	14.0	14.0	13.2	+ 6.1	1,677	1,547	+ 8.4
Ohio	9 7	10.2	8 9	+ 9.0	1,088	947	+ 14.9
Oklahoma	406.9	402.2	379.9	+ 7.1	48,405	44,833	+ 8.0
Pennsylvania	34.8	33.5	35.6	— 2.2	4,069	4,116	— 1.1
Tennessee	.....	.....	.....	.....	2	2	.....
Texas	2,417.9	2,401.7	2,178.5	+ 11.0	289,421	250,528	+ 15.5
Dist. 1—South Central	25.8	25.6	20.8	+ 24.0	3,101	2,408	+ 28.8
Dist. 2—Middle Gulf	172.2	170.4	158.0	+ 9.0	20 653	17.829	+ 15.8
Dist. 3—Upper Gulf	493.2	491.4	481.3	+ 2.5	59,870	54,897	+ 9.1
Dist. 4—Lower Gulf-S.W.	253.4	253.2	242.0	+ 4.7	30,761	27,384	+ 12.3
Dist. 5—East Central	46.0	43.5	38.1	+ 20.7	5,380	4,393	+ 22.5
Dist. 6—Northeast	438.2	443.9	445.0	— 1.5	52,470	51,080	+ 2.7
Dist. 7-B—North Central	44.4	43.2	37.0	+ 20.0	5,310	4,303	+ 23.4
Dist. 7-C—West Central	44.4	43.9	36.2	+ 22.7	5,304	3,932	+ 34.9
Dist. 8—West	678.6	667.4	486.8	+ 39.4	80.717	56,853	+ 42.0
Dist. 9—North	137.5	135.8	135.8	+ 1.3	16,963	15,296	+ 10.9
Dist. 10—Panhandle	84.2	83.4	84.9	— 0.8	10,471	10,038	+ 4.3
Virginia	0.1	0.1	0.3	— 66.7	12	31	— 61.3
West Virginia	7.7	7.5	6.7	+ 14.9	872	832	+ 4.8
Wyoming	141.4	140.8	117.4	+ 20.4	16,984	13,485	+ 25.9
Total United States	5,397.9	5,318.1	4,974.3	+ 8.5	645,896	580,881	+ 11.2

Completions

Up As Weather Clears

AFTER two months of retarded drilling operations the industry's drillers came back strong in April to complete 3180 wells. Activity had been slowed during February and March by severity of the weather in some parts of the country and as result the number of completions were 2601 and 2612, respectively. But by April the weather had warmed and the rains had moderated allowing drilling to again resume the tempo that characterized the start of the year.

The year had got off to a faster than normal start with almost 3000 wells being completed in January and then came the slackening that lasted for the next several months and then back to full speed in April. One consolation comes from the fact that wells that were not drilled in February and March due to inclement weather did not draw from precious stockpiles of tubular goods and those supplies can now be used in catching up and it appears that some of this happened in April. Regardless of temporary delays and slackened periods, it will be safe to expect that every well that can possibly be drilled with the available steel supplies will have been drilled or started by the end of 1948. Tubing and casing supplies, not the weather, are the factors that will limit this year's drilling program.

April's 3180 well completions were almost 30 percent greater than the 2455 wells finaled in the same month of last year, and the combined footage of these wells showed about the same difference, except that the later period had a little better edge with a slightly deeper average per well.

At the end of four months the current year held a substantial lead over 1947 in wells completed. There were 11,340 wells completed during the first one-third of 1948, an increase of almost 18 percent when compared with 9618 wells in the same period of 1947. A year ago new wells averaged 3469 feet each during the four-month period, while a slightly deeper average of 3490 feet was recorded in the four months just passed.

Well Completions in the United States During April, 1948, and Cumulative for Year

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon, and Allegany fields of Pennsylvania and New York from The Producers' Monthly.

STATE OR DISTRICT	MONTHLY COMPLETIONS, APRIL, 1948 — NEW WELLS: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New	Total Drilled Deeper	TOTAL COMPLETIONS: April, 1948	Mar., 1948	April, 1947	Footage April, 1948	CUMULATIVE TOTAL: Wells 1948	Wells 1947	Percent Diff.	Footage 1948	Rigs in Operation (Drilling, Rigging Up and Shut Down): April 30, 1948	Mar. 31, 1948	April 30, 1947
Alabama				2				2		2		2	12,625	4	6	— 33.3	24,360	3	2	3
Arizona																		7	7	2
Arkansas	9	1	1	16				27		27	13	22	119,988	92	71	+ 29.6	370,879	35	41	33
California	134		1	43				178	7	185	197	151	638,145	804	633	+ 27.0	2,812,340	276	280	282
Colorado	15			4				19		19	18	10	104,729	86	47	+ 83.0	468,463	58	63	48
Florida				2				2		2	1	2	12,239	8	10	— 20.0	52,964	4	4	7
Georgia											2			2	1	+100.0	8,871			
Illinois	59		2	67				128		128	104	123	317,981	556	587	— 5.3	1,406,582	242	192	185
Indiana	28			30	1			59		59	72	38	124,101	274	151	+ 81.5	505,376	111	88	82
Kansas	122		21	85			3	231		231	165	194	769,568	793	754	+ 5.2	2,621,392	284	299	284
Kentucky	15		23	13				51		51	52	51	102,161	212	221	— 4.1	437,649	75	67	112
Louisiana	127	13	7	53				200		200	152	95	997,598	608	393	+ 54.7	3,102,386	227	190	161
North Louisiana	85	4	6	29				124		124	101	53	328,567	375	201	+ 86.6	1,011,174	76	54	62
South Louisiana	42	9	1	24				76		76	51	42	669,031	233	192	+ 21.4	2,091,212	151	136	99
Maryland														1			5,259			
Michigan	20			24				44		44	37	26	110,761	193	142	+ 35.9	460,149	120	97	115
Mississippi	15		1	8				24		24	33	33	182,976	123	103	+ 19.4	1,035,903	48	50	97
Missouri	3		1	2	3			9		9	6	5	3,163	21	19	+ 10.5	6,659	7	7	2
Montana	6		2	6				14		14	25	13	34,077	88	31	+183.9	228,227	49	46	34
Nebraska														1			4,965			6
Nevada																		1	1	
New Mexico	41		6	17				64	4	68	41	41	255,686	215	182	+ 18.1	856,487	110	107	109
New York	78		1	1	50			130		130	132	129	187,406	554	488	+ 13.5	806,876	171	165	156
North Carolina															1	100.0				
Ohio	32		37	37				106	3	109	109	112	263,994	380	407	— 6.6	1,037,610	225	199	249
Oklahoma	218		21	138			1	378	10	388	245	308	1,313,776	1,248	1,197	+ 4.3	4,286,538	581	556	497
Pennsylvania	102		39	15	91	16		263		263	257	268	455,134	1,030	1,052	— 2.1	1,802,868	369	348	360
South Dakota				1				1		1			1,365	1			1,365		1	
Tennessee											5	1		10	6	+ 66.7	16,550	20	20	10
Texas	696	14	30	355	2	2	5	1,104	13	1,117	857	753	4,649,206	3,654	2,788	+ 31.1	15,622,622	1,458	1,350	1,160
Dist. 1—S. Central	24			23			1	48	1	49	41	29	133,127	170	104	+ 63.5	521,708	49	56	22
Dist. 2—Middle Gulf	42	3	2	32		1		80	3	83	53	50	484,276	258	203	+ 27.1	1,474,871	66	73	52
Dist. 3—Upper Gulf	50	7	3	42				102	1	103	73	65	651,486	318	257	+ 23.7	2,115,584	141	119	92
Dist. 4—L. Gulf-Sw	65	3	5	50				123	1	124	110	84	600,361	430	345	+ 24.6	2,131,629	125	110	94
Dist. 5—E. Central	7			7				14		14	17	11	62,404	57	36	+ 58.3	295,592	32	30	23
Dist. 6—Northeast	16	1	6	4			1	28	2	30	36	43	159,847	128	152	— 15.8	699,543	55	48	60
Dist. 7-B—N. Central	61		2	57				120		120	97	69	357,373	412	252	+ 63.5	1,249,973	165	148	121
Dist. 7-C—W. Central	24			5	1			30		30	32	20	122,850	121	68	+ 78.0	464,129	78	66	62
Dist. 8—West	244		2	31				277	3	280	220	168	1,222,929	915	573	+ 59.7	4,179,403	495	475	353
Dist. 9—North	111			95	1	1	3	211	2	213	153	187	615,835	666	649	+ 2.6	1,924,371	109	105	167
Dist. 10—Panhandle	52		10	9				71		71	25	27	238,718	179	149	+ 20.1	565,819	143	120	114
Utah				2				2		2	2	2	9,128	8	2	+300.0	31,064	9	11	5
Virginia														1			2,301			
Washington				1				1		1			6,278	1			6,278	1	1	1
West Virginia	11		41	13				65	4	69	57	58	175,124	251	261	— 3.8	628,348	390	330	382
Wyoming	30			5				35	2	37	30	18	149,066	121	65	+ 86.2	502,545	119	104	52
Total United States	1,761	28	234	940	147	18	9	3,137	43	3,180	2,612	2,455	10,996,275	11,340	9,618	+ 17.9	39,153,876	5,000	4,626	4,434

Exploration

Highest Since October

EXPLORATORY drilling got back into stride during April after a two-month period that saw drilling in general greatly curtailed. Drillers in some areas had to contend with cold and very wet weather during February and March and the record of wells completed during those periods clearly reflected the difficult conditions. But with April's warmer and dryer weather, drilling activity again hit the pace that was being set at the close of 1947 and in January of this year.

From the standpoint of total exploratory wells completed and those that proved to be producers, the month of April was quite satisfactory. The completed wells that were seeking new pools of oil and gas and those that were attempting to extend known pools numbered 516, the highest since October of last year. Of these wells 112 were successful for a score of 21.7 percent of the total. As it has been in the past and is certainly now in this era of tight crude supply, the oil discoveries are of prime importance, and in this department the industry was unusually successful. Forty new oil fields were added to the list of U. S. producing areas and 35 new oil pay strata in existing fields were discovered to make important additions to currently needed production and to reserves needed to insure future supplies.

Noteworthy, along with April's successful exploration, was the completion of the world's deepest producing oil well. Stanolind Oil & Gas Company completed its Garvin County, Oklahoma, wildcat in the Basal Bromide formation of Ordovician age to lay claim to the world's deepest producer. Pay was topped at 14,042 feet and the base is as yet undisclosed. Regardless, it bettered the old titleholder, The Texas Company's discovery well of the Queen Bess

Results of Exploratory Drilling in April and First 4 Months, 1948-1947, by Districts

State or District	MONTH OF APRIL, 1948														FIRST FOUR MONTHS, 1948															
	Productive Tests										Unproductive Tests			Total Exploratory Tests	Productive Tests									Unproductive Tests				Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive					New Fields			New Pays			Extensions			Total Productive				Total Dry			
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts		Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	1948	1947	Wildcats	New Pays	Outposts	4 Mo. 1948	4 Mo. 1947	4 Mo. 1948	4 Mo. 1947
Alabama											2			2												4			4	4	4	4
Arkansas											11			11	2									2	2	27			27	15	29	17
California	1			1			3			5	13			18	4			3			3	1		11	8	70			70	79	81	87
Colorado											3			3											1	18			18	10	18	11
Florida											1			1												5			5	10	5	10
Georgia																										2			2	1	2	1
Illinois				3			3			6	29			35	5			10			8			23	36	120			120	95	143	131
Indiana	1			1						2	19			21	4		1	3						8	6	54			54	24	62	30
Kansas	9			2						11	37			48	21			2			1			24	26	124	1		125	97	149	123
Kentucky	1									1	4			5	1		1				1			3	3	10			10	19	13	22
Louisiana		1	1	6	1		1	1		11	19			30	2	2	1	14	5		1	3		28	25	69		1	70	65	98	90
North Louisiana				1			1	1		3	9			12	1			1			1	2		5	3	33			33	39	38	42
South Louisiana		1	1	5	1					8	10			18	1	2	1	13	5			1		23	22	36		1	37	26	60	48
Maryland																										1			1		1	
Michigan			2				1			3	17			20	3		3				1			7	3	72			72	59	79	62
Mississippi											4			4							1			1	4	27			27	17	28	21
Missouri																														7		7
Montana											1			1	1						1			2		11			11	4	13	4
New Mexico				1						1	6			7	4	1		3		1				9	5	22			22	17	31	22
North Carolina																														1		1
Ohio									3	3	4			7	1								6	7		13			13	18	20	18
Oklahoma	7		1	2						10	41			51	16	2	5	11			2			36	38	145		1	146	202	182	240
Pennsylvania																										2			2		2	
South Dakota											1			1												1			1		1	
Tennessee																										7			7	6	7	6
Texas	21	2	3	14	2	4	8			54	180		7	241	85	6	13	53	13	14	23	2	1	210	153	645	4	19	668	445	878	598
Dist. 1 S. Central	1									1	16			17	1			1		1				3	3	60			60	41	63	44
Dist. 2 Middle Gulf	1	1	1	2	1		1			7	20		3	30	7	1	1	7	6	2	2	1		27	17	64	1	5	70	42	97	59
Dist. 3 Upper Gulf	2			7			1			10	24			34	5	2		15	2	2	3	1		30	27	80		2	82	44	112	71
Dist. 4 L. Gulf-S.W.	3			1	1	4				9	23		2	34	6	2	2	8	5	9	1			33	35	100	1	7	108	75	141	110
Dist. 5 F. Central	1									1	4			5	2			2			1			5	3	22			22	20	27	23
Dist. 6 Northeast		1		1						2	5			7		1		4			4			9	2	27	1		28	21	37	23
Dist. 7-B N. Central	5		1	1			1			8	35			43	28		7	9			1			45	22	110			110	72	155	94
Dist. 7-C W. Cent.				1						1	3			4	6			1						7	6	27			27	8	34	14
Dist. 8 West	5		1	1			2			9	12		2	23	13		2	2			5		1	23	13	50	1	4	55	40	78	53
Dist. 9 North	3						3			6	36			42	17		1	4			6			28	23	103		1	104	79	132	102
Dist. 10 Panhandle											2			2											2	2			2	3	2	5
Utah											2			2												8			8	2	8	2
Virginia																		1						1							1	
Washington											1			1												1			1		1	
West Virginia																		2						2	1						2	1
Wyoming				5						5	2			7	2			8			2			12	5	12		1	13	14	25	19
Total U.S.	40	3	7	35	3	4	16	1	3	112	397		7	516	151	11	27	107	18	15	44	6	7	386	315	1470	5	22	1497	1211	1883	1527

Island field, South Louisiana, that produced gas and condensate from 13,904.

However, fame was short-lived for Stanolind's champion, for early in May came reports from the Rocky Mountain Region that The Pure Oil Company had a new well that had outdone them all, both deeper and better. This company's West Poison Spider wildcat, located on the eastern flank of Wind River Basin, Wyoming, is producing from 14,191—307 feet in the Frontier formation, and made on initial test 1413 barrels of 43.5-gravity oil in 41 hours through ¾-inch choke. This discovery is currently being called one of the most significant finds in the Mountain states and goes a long way toward scrapping the widely accepted theory that compression of sediments at great depths in the region would prevent large accumulations of crude. It will probably cause some reconsideration of deep-seated basin prospects and result in additional deep drilling in the Rocky Mountain states. This well is not included in the accompanying listing of discoveries, but will appear with those for May.

In the first four months of this year exploratory well completions totaled 1883, an increase of 23.3 percent over 1527 drilled in the first one-third of last year. A year ago at this time 316 wells had been successfully completed, which was 20.7 percent of the total, while so far this year 386 amounted to 20.5 percent. Of these producers 151 opened new oil fields compared with 121 of the same class last year and 107 found new oil horizons against 91 a year ago.

Although Texas has long been the major producer and drilling state, it is now accounting for an even greater share of the exploratory drilling. So far this year more than 46 percent of the nation's exploratory wells were drilled in Texas and a year ago it accounted for 39 percent. Of the 356 more completions in four months of 1948 than in the same period a year ago, Texas furnished 280.

Summary of Results of Exploratory Drilling

ITEM	April, 1948	Mar. 1948	FOUR MONTHS JAN.-APRIL 1948	1947	Percent Diff.
Oil Discoveries	75	47	258	212	+ 21.7
New Fields	40	34	151	121	+ 24.8
New Pays	35	13	107	91	+ 17.6
Distillate Discoveries	6	9	29	28	+ 3.6
New Fields	3	2	11	11	.....
New Pays	3	7	18	17	+ 5.9
Gas Discoveries	11	11	42	32	+ 31.3
New Fields	7	6	27	24	+ 12.5
New Pays	4	5	15	8	+ 87.5
Total Discoveries	92	67	329	272	+ 21.0
Extension to Fields	20	13	57	44	+ 29.5
Oil Fields	16	9	44	36	+ 22.2
Distillate Fields	1	1	6	4	+ 50.0
Gas Fields	3	3	7	4	+ 75.0
Total Prod. Tests	112	80	386	316	+ 22.2
Dry Holes	404	341	1497	1211	+ 23.6
Wildcats	397	332	1470	1169	+ 25.7
New Pays	.....	3	5	21	— 76.2
Outposts	7	6	22	21	+ 4.8
Total Exp'tory Tests	516	421	1883	1527	+ 23.3
Percent Productive	21.7	19.0	20.5	20.7	.....
Percent Dry	78.3	81.0	79.5	79.3	.....

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in April, 1948

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		CALIFORNIA—New Oil Field						
Los Angeles	Placerita Crk.	Nelson-Phillips Oil Co's Kraft 1, 878 n 1750 w fr sec Sect 31-4n-15w	4-21-48	2242	580- 714	.....	F 75	15.6
		CALIFORNIA—New Oil Pay						
Los Angeles	Potrero	Barnsdall Oil Co's RSF 65-7, 3231 s 6846 e fr cor Sect 26-4n-17w	4-10-48	12717	11150-11305	7 th zone	F 431; 32/64"	28
		CALIFORNIA—Oil Field Extensions						
Kern	Kern Bluff	Rocket Pet. Co's Zimmer 1, 200 s 200 w fr e¼ cor Sect 12-29s-28e, ½ mi w extension.	4-10-48	1207	1140- 1180	Sta. Margarita, Mio	P 40	15
Monterey	San Ardo	The Texas Co's Rosenberg 3, 2875 s 1266 w fr nec Sect 34-22s-10e, ⅜ mi s extension.	4- 2-48	2478	2160- 2190	.....	P 30	10
Ventura	Padre Canyon	Chanslor-Canfield-Midway Oil Co's Hobson B-50, 2599 s 4521 e fr nwc Sect 16-3n-24w.	3- 9-48	5260	4165- 4670	Intermediate Zone	F 236; 3/8"	30.6
		ILLINOIS—New Oil Pays						
Gallatin	Inman, W	Kingwood Oil Co's Fillingham 1, nw sw nw 22-8s-9e	4-13-48	2984	2828- 2832	L O'Hara li; Miss	P 3; 25 wtr	....
Jefferson	Divide, E	National Assoc Pet. Co's McElravy 3, ne sw se, 17-1s-4e	4-20-48	2732	2729- 2732	Rosiclare li; Miss	P 175	....
Wabash	Maud	C. E. Skiles' E. Alka 2, se sw se 34-1s-13w	4-20-48	2678	2608- 2614	L O'Hara li; Miss	P 70	....
		ILLINOIS—Oil Field Extensions						
Franklin	Thompsonville, N.	Froderman-Conley's Carter 1, se nw ne, 15-7s-4e, ½ mi nw extension	4-13-48	3146	3136- 3146	Aux Vases sd; Miss	P 60	....
Jefferson	Divide, E	Bell Bros' Warren Heirs 1, (OWWO) se se se ,18-1s-4e, ½ mi w extension	4-13-48	2808	2746- 2779	McClosky li; Miss	P 51; 2 wtr	....
Wayne	Fairfield	Robinson & Puckett's A. Wood 1, s ne nw, 16-2s-8e, 1¼ mi ne extension	4-20-48	3202	3184- 3202	Aux Vases sd; Miss	P 225; 5 wtr	....
		INDIANA—New Oil Field						
Posey	Mt. Vernon, E	Indiana Farm Bureau's Louis Hohstadt 1, nw sw ne, 33-6s-13w, Black Twp.	4- 9-48	2983	2895- 2900	McClosky li; Miss	P 87	....
		INDIANA—New Oil Pay						
Pike	UnionBowman	Wabash Pet Corp's M. Robling 3, nw nw sw 32-1n-9w	4-30-48	1650	1644- 1647	Rosiclare li; Miss	F 195; 40 wtr	....
		KANSAS—New Oil Fields						
Butler	.....	Rex & Morris et al's Rice 2, se se ne 5-26s-4e	4-20-48	2568	2566- 2568	Viola li; Ord	P 50	....
Dickinson	.....	Hutchinson O&G Co's Daetwiler 1, sw sw nw 33-16s-4e	4-30-48	2342	2311- 2342	Mississippi li; Miss	P 50	....
Ellis	.....	Westgate-Greenland's Simpson 1, nw nw se 9-11s-17w	4-27-48	3438	3114- 3124	Lansing li; Penn	P 25	....
Ellis	Canyons	Cities Service Oil Co's Hall "M" 1, se se se 11-12s-17w	4-30-48	3690	3331- 3512	Lansing li; Penn	P 170; 48 wtr	34.2
McPherson	.....	Westgate-Greenland et al's Ruth 1 (OWWO), ne ne sw 13-18s-1w	4-27-48	2830	2806- 2830	Mississippi li; Miss	P 317	39
McPherson	Twin Mtn	Don Ingling et al's Miller 1, se se nw 1-18s-2w	4-20-48	2851	2842- 2851	Mississippi li; Miss	P 858	35
Rice	.....	Brainine, Holl & Allan's Turner 1, se se se 6-21s-6w	4-27-48	3507	3498- 3507	Mississippi li; Miss	P 40	....
Russell	Ney	Wood River O&R Co's Ney "A" 1, sw sw ne, 31-15s-12w	4-30-48	3363	3118- 3250	Lansing-Kansas City; li; Penn	P 26; 11 wtr	....
Stafford	.....	Phil-Han Oil Co's Hufford 1, sw sw nw 33-21s-13w	4-27-48	3770	3755- 3770	Arbuckle li; Ord	P 368	30
		KANSAS—New Oil Pays						
Barton	Kowalsky, NW.	Gough Davis & El Dorado Refg. Co's De Werff 1, ne se se, 25-20s-12w	4-27-48	3411	3188- 3192	Lansing-Kansas City li; Penn	P 20; 15 wtr	....
Russell	Ney	Wood River O&R Co's Ney "B" 1, nw nw se, 31-15s-12w	4-30-48	3355	3349- 3355	Arbuckle li; Ord	P 222	....
		KENTUCKY—New Oil Field						
Henderson	.....	Ashland O&R Co's Fannie Royster 1 (OWWO), 11-O-23, n of Robards pl	4-20-48	2746	2502- 2511	O'Hara li; L Miss	P 19; 5 wtr	....
		NORTH LOUISIANA—New Oil Pay						
Caddo	Caddo-Pine Island	H. J. Strief's Central Trading Co 1, 2310 fr nl 990 fr wl, 34-22n-15w	4- 1-48	4504	3183- 3195	.....	F 5; ¼"	....
		NORTH LOUISIANA—Oil Field Extension						
Union	Ora	Shell Oil Co's Frost Lbr A-37, 50 n of c nw sw sw, 12-22n-1w, 1 mi n extension	4- 1-48	2108	2098- 2108	Nacotach sd; U. Cre	P 103; 156 w	36.3
		NORTH LOUISIANA—Distillate Field Extension						
DeSota	Logansport	Skelly Oil Co's Levi Burkett 1, 200 s&e of cent 21-12n-16w, 1 mi e extension	4-23-48	6602	6080- 6112	L Pettit li; L Cre	F 65; 2 mln; 3/4"	42
		SOUTH LOUISIANA—New Oil Pays						
Acadia	Iota	Sohio Pet Co's D. A. Burnell 1, Sect 14-8s-2w	4-19-48	8754	8666- 8698	.....	F 292; 32/64"	31.8
Jefferson	Bay De Chene	The Texas Co's State Bay De Chene Lse 356-5, Twp 19s-24e	4- 5-48	9556	6862- 6878	.....	F 168; 32/64"	33.3
LaFourche	Bully Camp	Gulf Ref Co's Delta Securities Co 20, Sect 36-19s-21e	4-26-48	10136	7788- 7798	.....	F 210; 16/64"	35.9
St. Mary	Horseshoe Bayou	The Texas Co's State-St. Mary Parish Land Co, Unit 1-6, 7301 s 2431 e of nwc Sect 15 in Sect 40-17s-9e.	4-11-48	12102	11994-12004	.....	F 443; 32/64"	35.1
St. Mary	West Cote Blanche Bay	The Texas Co's State-West Cote Blanche Bay Lse 340-30, Twp, 16s-7e	4-10-48	10008	6553- 6564	.....	F 225; 32/64"	31.7

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches

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Cement, Oklahoma City, Seminole, Tulsa

•

TEXAS
Abilene, Alice, Big Spring, Borger, Columbus, Corpus Christi, Dallas, Electra, Falfurrias, Fort Worth, Hebbronville, Houston, K-M-A, Kennedy, Kermit, Kilgore, Nocona, McAllen, Monohans, Odessa, Olney, Pampa, Pleasanton, San Antonio, Sundown, Talco, Victoria, Wichita Falls.

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General Offices
Houston, Texas

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in April, 1948 (Continued)

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		SOUTH LOUISIANA—New Distillate Field						
Calcasieu		Sohio Pet & General Crude Oil Co's Sweet Lake Ld & Oil Co 1-B, n 89 deg 98 min w 669.2 & n 702 fr sec. Sect 30-10s-6w.	4- 9-48	10843	10736–10750		F 31; 2.1 mln; 8/32"	48
		SOUTH LOUISIANA—New Distillate Pay						
LaFourche	Valentine	The Texas Co's Luke Guidres 1, 397 s 531 w of nec, Sect 51-17s-20e, 1 mi se extension.	3-24-48	12780	11036–11091		F 25; 4.9 mln; 4/16"	51.4
		SOUTH LOUISIANA—New Gas Field						
Plaquemines		Barnsdall Oil Co's Breton-State Lse 1230-1-36, 360 n 1070 w Tri Sta "North Point". 7065 w 1765 n of sec Blk 36, Breton Sound.	4-30-48	10600	4162– 4168		2.4 mln; ¼"	
		MICHIGAN—Oil Field Extension						
Van Buren	Geneva	Norman L. Stevens' Tranker 1, sw sw sw 21-1s-16w, Geneva Twp.	4-16-48	1012	1010– 1012	Traverse li; Devo	P 12	
		MICHIGAN—New Gas Fields						
Muskegon		Rex Oil & Gas Co's Todd 1, sw sw nw 26-10n-13w, Casnovia Twp.	4-16-48	2293	1532– 1680	Berea sd; Miss	0.1 mln	
Gratiot		Harper & Turner Oil Co & Sohio Pet Co's Rudd McLaren 1, nw se nw 25-10n-4w, New Haven Twp.	4-23-48	987	979– 987	Stray sd; Miss	4.3 mln	
		NEW MEXICO—New Oil Pay						
Eddy	Grayburg-Keeley	Western Prod Co's Keeley-C-27, 990 fr nl 330 fr wl Sect 26-17s-29e.	4- 1-48	3407	3296– 3322	Slaughter sd; Perm	F 99; 4/16"	38.6
		NEW MEXICO—New Gas Pay						
Lea	Bowers	Gulf Oil Corp's Grimes 4 (OWWO), 330 fr nl 2310 fr wl Sect 32-18s-38e.	1-24-48	4153	3630– 3700	Permian	0.3 mln; ¾"	
		OHIO—Gas Field Extensions						
Athens	Lancaster	John Morrow et al's Republic Coal Co 1-C, Trimble Twp.	4-12-48	3631	3600– 3610	Clinton sd, Sil	0.2 mln	
Cuyahoga	Ashland-Lorain	Rock Ridge Co's G. W. Hausheer Co 1, Lot 33, Parma Twp.	4-13-48	3120	3090– 3104	Clinton sd; Sil	1.3 mln	
Stark	Sandyville	Lloyd Smail et al's C. M. Smith 1, se se 35 Tuscarawas Twp.	4- 1-48	4286	4130– 4133 4228– 4240	Shell; Sil Clinton sd; Sil	0.3 mln	
		OKLAHOMA—New Oil Fields						
Creek		Deardorf Oil Co's Conner 1, se ne nw 9-19n-7e.	4- 8-48	2664	2615– 2658	Skinner sd; Penn	P 30	37
Grady	Bradley, SW	Stanolind Oil & Gas Co's Briscoe 1, c nw se 4-4n-5w.	4-29-48	15097	[1]4042–	Basal Bromide sd; Ord	F 138; ¾"	
Hughes		H. T. & M. Phillips Pet. Co's Meadors 1, ne se nw, 18-9n-11e.	4-22-48	3008	2978– 3008	Cromwell sd; Penn	F 25; 2.4 mln; open	
Kay		Deardorf & Continental's Merhoff 1, se ne se 12-27n-1e.	4-15-48	4225	3581– 3692	Bartlesville sd; Penn	P 27; 3 wtr	37
Okfuskee		Skelly Oil Co's Bombarger 1, sw ne se 12-13n-7e.	4-30-48	4100	4025– 4039	Viola li; Ord	F 550; ½"	27.7
Oklahoma		L. C. Tharpe's Lovell 1, se nw se 29-13n-1e.	4-30-48	4897	4883– 4895	Cleveland sd; Penn	F 147; ¾"	36.5
Pottawatomie		R. W. Brown's Hibbard 1, se sw sw 21-6n-4e.	4-22-48	3746	3080– 3090	Wanette sd; Ord	P 5	42
		OKLAHOMA—New Oil Pays						
Garvin	Maysville, S	Texas Gulf Prod Co's McBride 1, ne se sw 32-4n-2w.	4-29-48	6893	6669– 6674	Bromide sd; Ord	F 137; ⅛"	40.7
Pottawatomie	Shawnee, E	Phillips Pet Co's Ailey 1, se sw ne 2-10n-4e.	4-29-48	4849	4843– 4849	1st Wilcox sd; Ord	P 40	31
		OKLAHOMA—New Gas Field						
Hughes		Cities Service Oil Co's Nicks 1, ne se nw, 12-8n-10e.	4-29-48	4330	2294– 2336	Booch sd; Penn	5.5 mln	
		TEXAS—District 1 (SOUTH CENTRAL)—New Oil Field						
Bastrop	"Jim Smith"	James E. Smith's T. J. Caldwell 1, 210 fr nel, 330 fr nwl, 172-ac Tr., Jose A. Navarro Gr.	4-21-48	1647	1608– 1647		P 31	
		TEXAS—District 2 (MIDDLE GULF COAST)—New Oil Field						
Jackson		Humble O&R Co's Four-Way Ranch D-2, 330 fr n&wl Lot 86, First Registered Subd of LaWard Farms in I&GN Sur 12.	4- 3-48	8710	5824– 5829		F 220; 5/32"	33.1
		TEXAS—District 2 (MIDDLE GULF COAST)—New Oil Pays						
Jackson	Ganado-Deep	The Texas Co's Mortgage Ld & Inv Co 11, 1313 fr nl 1865 fr el, 321.25-ac Lse, Morris & Cummings Sur 3.	4- 5-48	7678	6426– 6429		F 86; 7/64"	37.6
Refugio	Refugio-Fox	Seaboard Oil Co of Deleware's Jamie Hynes A-1, 330 fr nl 8900 fr el of Refugio Town Tr.	4-14-48	7020	6397– 6407		F 138; ⅛"	37.3
		TEXAS—District 2 (MIDDLE GULF COAST)—Oil Field Extension						
Karnes	Burnell-Wilcox	Stanolind O&G Co's J. E. Steed 1, 330 fr nwl 2494 fr swl, 192-ac Lse, D. B. Dhoate Sur, ⅜ mi ne extension.	4-26-48	6895	6863– 6868	Wilcox sd; Eoc	F 86; 7/64"	36
		TEXAS—District 2 (MIDDLE GULF COAST)—New Distillate Field						
Goliad	Marshall	Sunray Oil Corp's Fannie O. Marshall 1, 330 fr nel 2236 fr nwl, 1225.29-ac Lse, William Millican Sur.	4- 4-48	9240	8730– 8745	Luling sd; Eoc	F 518; ⅜"	
		TEXAS—Distrcit 2 (MIDDLE GULF COAST)—New Distillate Pay						
Live Oak	Chapa	Continental Oil Co's Somerset Ld & Cattle Co 4, 1650 fr sw&sel of T. T. R.R. Sur 319.	4- 2-48	10356	9160– 9200		F 120; 4.2 mln; 7/32"	55
		TEXAS—District 2 (MIDDLE GULF COAST)—New Gas Field						
Victoria		Cities Service Oil Co's Mrs. S. H. Baker 1, 660 fr nw&nel Blk 55, Allison-Richey Ld Co Subd of Roseborough Rch in Valentin Garcia Gr.	4- 1-48	6816	5240– 5249	Frio sd; Olig	7.4 mln; open	
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Fields						
Harris	"Rankin"	Sun Oil Co's Ruby Bossier 1, 392.7 fr n&sl 3320.9 fr el of 104.96-ac Lse, F. Rankin Sur.	4- 6-48	9015	8252– 8255		F 21; ⅛"	38.8
Lee	Tanglewood	Humble O&RCo's Geo. D. Vick et al 2, 1400 fr wl 2200 fr nl of 300-ac Tr No. 1, Bethel Smith ⅓ Lse.	4-27-48	6345	6332– 6341	Edwards li; L Cre	P 10; 4 wtr	31.3
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Pays						
Brazoria	Chenango, S	Pan American Prod Co's Louis Nawrocki Comm 1, 467 fr s&wl of 76.59-ac Lse, S. Marsh Sur.	4-24-48	9240	8954– 8965		F 127; 7/13"	31.6
Brazoria	West Columbia	The Texas Co's J. G. Phillips et al 26, (OWDD), 670 fr sl 323.5-ac Lse, Geo. Tennil Sur.	4-14-48	6435	6208– 6213		F 360; ¼"	31.5
Hardin	Beech Crk., E	American Republics Corp's H&TC Fee 2, 3990.5 fr el, 1280.5 fr sl of Sect 119, H&TC Sur.	4-17-48	7449	6711– 6714		F 154; ⅛"	38.5
Hardin	Saratoga	Cities Service Oil Co's Kariker Lbr Co Fee 7, 570 fr nl 430 fr wl 65.44-ac Lse. Nancy Fuller Lge.	4-13-48	5455	5064– 5110	Cerat (Cook Mtn. sd; Eoc	F 248; 11/4"	38.7
Liberty	Esperson	General Crude Oil Co's Pure Oil Co 1, (OWWO), 456 fr s&wl of 100-ac Lse, Sect 23, GC&SF Sur.	3- 6-48	9495	8875– 8915	Mid Yegua sd; Eoc	F 55; ⅛"	37.5
Newton	Sabine Tram	Gulf Oil Corp's J. R. Bevil Sr et al C-2, 2078.6 fr nl 1246.8 fr el of 560-ac Lse, R. I. Richardson Sur.	4- 2-48	8531	7785– 7789		F 38; 285 wtr; 1/4"	36
Polk	Livingston	Hawkeye Pet Co's L. G. Howard 1 (OWWO), 467 fr sl 367 fr el of 80-ac Lse, A. Viesca Lge.	4- 6-48	4100	3403– 3450		F 39; ¼"	32
		TEXAS—District 3 (UPPER GULF COAST)—Oil Field Extension						
Lee	Tanglewood	Humble O&R Co's Jim Johnson 1, 467 fr w&nl of 53-ac Lse, John Fulcher Sur, ½ mi ne extension.	4-19-48	6324	6305– 6324	Edwards li; L Cre	F 27; 4/16"	35
		TEXAS—District 4 (LOWER GULF-SW)—New Oil Fields						
Nueces	"Wood"	Rock Hill Oil Co & W. Earl Rowe's E. D. Wood 2, 330 fr n&el Sect 5, Wade-Riverside Subd.	4-23-48	7803	7490– 7494		F 120; 7/64"	41
Starr	"Coastal"	Coastal Refineries Inc & W. D. Kennard's Luis Pena B-1, 330 fr sl 1045 fr wl of 51.15-ac "B" Lse, Porcion 38.	3-26-48	5850	5760– 5775		F 39; 7/64"	42.5
Starr	"West Sun"	Humble O&R Co's E. Block Hrs 3, 5500 fr sl 5000 fr el of 3000-ac Lse, J. J. Sais Gr.	4-10-48	9206	8833– 8880		F 41; 4/16"	52.5
		TEXAS—District 4 (LOWER GULF-SW)—New Oil Pay						
Starr	Kennard	Coastal Refineries Inc & W. D. Kennard's M. M. Garcia E-6, 2310 w 330 n at ra fr nec Porcion 93.	4- 6-48	4275	3903– 3909		F 50; 5/32"	42.4
		TEXAS—District 4 (LOWER GULF-SW)—New Distillate Pay						
Starr	La Reforma	Baldridge & King et al's A. Guerra Unit 1, 150 fr nl 3051 fr wl Tr "J", San Jose Gr.	3-15-48	8594	8553– 8582		F no gge; 28 mln; open	

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

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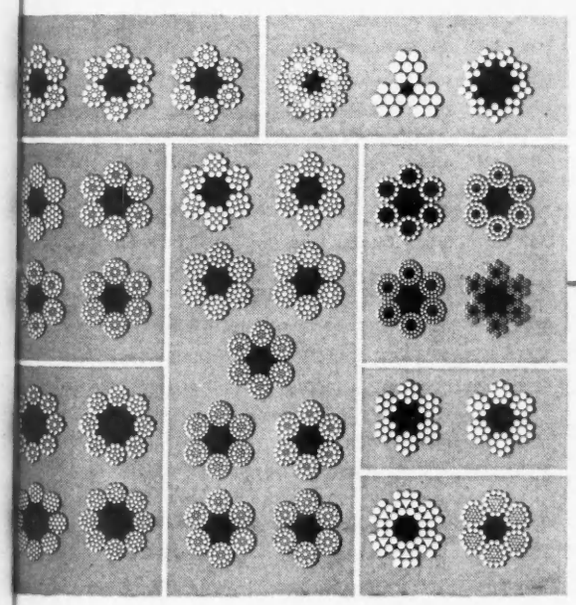

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in April, 1948 (Continued)

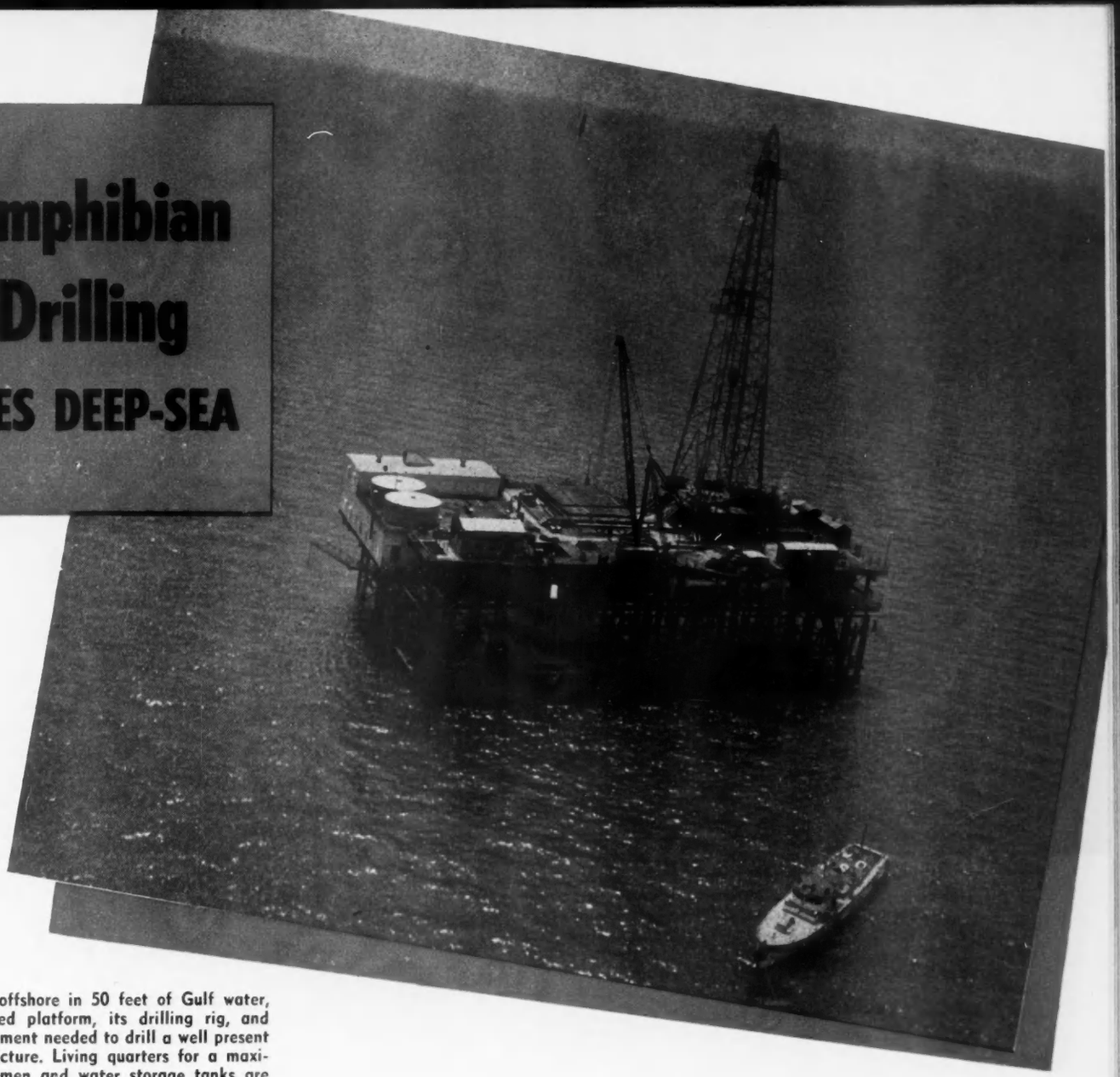
Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		TEXAS—District 4 (LOWER GULF-SW)—New Gas Pays						
Duval	Seventy-Six	Magnolia Pet Co's Duval-State 3, on 400-ac Lse, 1650 fr w&nl of GCSD&RGNG RR Sur 76.	4-30-48	2503	2100- 2110		20 mln; open	
Jim Wells	Premont	Barnsdall Oil Co's Thirkell 1, 330 e of wl of Lots 59 & 63 in line betw lots, Sect 77, SK&K Sur.	3-25-48	6113	4421- 4442		4.5 mln; open	
Nueces	Nueces Bay	Phillips Pet Co's Nueces Bay-State 1, 4620 fr sl 1980 fr wl of State Tr 706 in Nueces Bay.	4- 8-48	10935	3290- 3300		10 mln; open	
Starr	Boyle	Continental Oil Co's M. M. Garcia D-14, 330 fr wl 1430 fr nl of Sur 908.	4- 3-48	4518	3780- 3797	"H" sd; Olig	1.8 mln; open	
		TEXAS—District 5 (EAST CENTRAL)—New Oil Field						
Denton		Anco Gas Corp & C. B. Slemp's Bessie B. Forrester "F" 2, 330 fr s&nel of Lse, Wm. Nelson Sur.	4-27-48	1772	1762- 1771		P 27	
		TEXAS—District 6 (NORTHEAST)—New Oil Pay						
Wood	Coke	J. C. Hawkins' J. M. Clark 1, 990 n of sl 940 e of wl of w 40-ac of 134.62-ac. Tr.	4-11-48	4137	4056- 4062	Sub-Clarksville sd; U Cre	P 128	15.2
		TEXAS—District 6 (NORTHEAST)—New Distillate Field						
Smith		Magnolia Pet & Sinclair Prairie's R. W. Fair 1, 2250 s of nl 660 e of wl of Wm. Schofield Sur.	4- 9-48	10493	9512- 9581	Rodessa li; L Cre	F 75· 0.9 mln; open	59
		TEXAS—District 7-B (NORTH CENTRAL)—New Oil Fields						
Shackelford		Welch & White's C. A. Nail 1, 220 fr n&el of sw¼ of se¼ Sect 126, ETRR Sur.	4- 9-48	1345	1343-1345		F 26; ½"	37
Stephens		Fred M. Manning's W. T. Moore "B" 1, 467 fr s&el Sect 2256, TE&L Sur.	4-20-48	3388	3325- 3330	Caddo li; Penn	P 228; $\frac{7}{64}$"	43.2
Stephens		Kadane-Griffith Oil Co et al's J. N. Davis 1, 467 fr sl 3573 fr wl Sect 1546, TE&L Sur.	4-23-48	4450	4434- 4450	Ellenburger li; Ord	F 544; $\frac{11}{64}$"	44
Throck-morton		Saguaro Drlg Co's Saguaro-Herron "A" 1, 330 fr n&el Sect 1606, TE&L Sur.	4-14-48	4813	4798- 4808	Mississippian	P 28	
Throck-morton		Deep Rock Oil Corp & Jennings' Elle Andrews 1, 330 fr s&el of sw¼ Sect 284, BBB&C Sur.	4-26-48	4850	4768- 4778	Marble Falls li; Penn	P 28	
		TEXAS—District 7-B (NORTH CENTRAL)—New Oil Pays						
Coleman	(Not designated)	S. B. Roberts et al's J. E. McCord 1, 330 fr nl 1650 fr wl Sect 21, BS&F Sur.	1- 4-48	3730	3365- 3403	Capps sd; Penn	F 24; 4 wtr; $\frac{8}{64}$"	39
Palo Pinto		F. O. B. Oil Co's (was J. H. Flippo et al) S. B. Cantey 1, 330 fr sl 990 fr wl Sect 25, Blk 3, T&P Sur.	2-17-48	4295	4293- 4295	Ellenburger li; Ord	P 96; 9 wtr	40
Taylor	Patterson	Geochemical Survey's J. Patterson et al 3, 330 fr nwl 990 fr nel of Blk 17, Grimes CSL Lge 148.	1- 7-48	2584	2574- 2584	Flippen sd; Penn	P 92	40
Throck-morton	Bailes	James H. Snowden et al's G. T. Gober 1, Sect 3 DL&C Sur. ½ mi se extension	4- 1-48	4774	4464- 4469	Caddo li; Penn	F 597; $\frac{3}{16}$"	43.2
Throck-morton	(Not Designated)	Fred M. Manning Inc's L. C. Atkinson "E" 1, 467 fr nl 1600 fr wl Sect 967, TE&L Sur.	2- 8-48	4720	2556- 2576	Strawn sd; Penn	F 108; $\frac{1}{16}$"	40
Throck-morton	(Not Designated)	James H. Snowden et al's T. J. Wright 2, 1050 fr sl 2600 fr wl Sect 294, BBB&C Sur.	2-17-48	4383	4240- 4246	Caddo li; Penn	F 422; ¼"	41.6
Throck-morton	Odell	Woodley Pet Co's J. T. Odell 4, 904 fr el 1020 fr sl Sect 696, TE&L Sur.	2-18-48	4926	4112- 4118	Caddo li; Penn	F 135; $\frac{11}{64}$"	37
Throck-morton	(Not Designated)	J. H. Snowden's Bailes-Parmenter-Jones 3, 467 out of sec Sect 292, BBB&C RR Sur.	1- 3-48	4809	4518- 4529	Marble Falls sd; Penn	F 320; ¼"	
Throck-morton	McKnight	Fred M. Manning et al's Jack McKnight 8, 330 fr nl 4423 fr wl of Lse, F. A. Richardson Sur.	1- 5-48	4577	4557- 4577	Mississippi li; Miss	F 194; $\frac{11}{64}$"	45
		TEXAS—District 7-B (NORTH CENTRAL)—Oil Field Extension						
Throck-morton	Throck-morton Co.	Prairie O&G Co's E. B. Lee 1, 2000 fr nl 990 fr el Sect 2203, TE&L Sur, 1 1 mi e extension.	4- 7-48	3932	3925- 3932	Caddo li; Penn	F 157; $\frac{3}{16}$"	42.6
		TEXAS—District 7-B (NORTH CENTRAL)—New Gas Fields						
Brown		Hickok & Reynolds Inc's Blanche McKenzie "A" 1	4-19-48	3083	1430- 1442		2 mln	
Stephens		Andrews & Associates' Ona Repass 1, 330 fr nl 1150 fr el Sect 1099, TE&L Co Sur.	2-20-48	4701	4080- 4085	Marble Falls sd; Penn	8.4 mln; 2"	
		TEXAS—District 7-C (WEST CENTRAL)—New Oil Pay						
Crockett	Blk 47	Continental Oil Co's University 1-A-13, 1980 fr sl 660 fr el Sect 13, Blk 47, University Lds Sur.	4- 1-48	10232	9230- 9305	Silurian	P 104; 30 wtr	45
		TEXAS—District 8 (WEST)—New Oil Fields						
Andrews		Phillips Pet Co's University 5-M, 1989 fr sl 1983 fr el Sect 31, Blk 13, University Lands Sur.	4- 1-48	10828	10590-10645	Ellenburger dolo; Ord	F 740; ¼"	44
Cochran		Anderson-Prichard Oil Corp's Minnie S. Veal 1, 440 fr s&el Tr 8 Lge, 114, Potter CSL Sur.	3-21-48	5038	4920- 4959	San Andres dolo; Perm	F 326; 1"	32
Hale		General American Oil Co's A. F. Byrd 1 (OWWO), 1980 fr nl 660 fr el Sect 17, Blk K, TT RR Sur.	4-20-48	8756	5830- 5895	Canyon li; Penn	P 118; 61 wtr	40
Pecos	"Orient"	R. R. Herrell et al's W. C. Jackson-State 1, 1650 fr sl 330 fr el Sect 102, Blk 8 H&GN Sur.	4- 2-48	1826	1790- 1815	Yates sd; Perm	F 66; ½"	27.5
Sterling		Anderson-Prichard & Vickers Petroleum's Marvin F. Foster 1, 660 fr s&wl of Sect 12, Blk 15, H&TC Sur.	4-29-48	8230	4252- 4295	Wichita Albany; Perm	F 846; ¾"	26.5
		TEXAS—District 8 (WEST)—New Oil Pay						
Ector	Jordan-Tubb	Gulf Oil Corp's W. E. Connell 21-T-B, 555 fr sl 2304 fr el Sect 26, Blk B-16, PSL Sur.	4- 1-48	5270	5242- 5270	Tubb li; Perm	F 817; ⅜"	42.2
		TEXAS—District 8 (WEST)—Oil Field Extensions						
Hockley	Levelland	Geo. P. Livermore Inc's David Parsons 1, 440 fr n&wl Lab 25, Lge 30, Baylor CSL Sur, s extension.	4-15-48	4909	4865- 4909	San Andres li; Perm	F 188; open	31
Pecos	Ft. Stockton	Humble O&R Co's Fred Turner, Jr., et al 1, 660 fr sl 3626 fr wl Sect 18, Blk 119, GC&SF Sur, 1 mi n extension.	4-30-48	3010	2870- 2900	Yates sd; Perm	P 39; 27 wtr	27.9
		TEXAS—District 8 (WEST)—New Gas Field						
Pecos		LaGloria Corp's H. L. Winfield 1, 330 fr s&wl Sect 10, Blk 132, T&STL Sur.	4- 5-48	4032	3975- 3994	Clear Fork sd; Perm	1 mln	
		TEXAS—District 9 (NORTH)—New Oil Fields						
Archer		Akin & Dimmock's Mrs. J. H. Turbeville 1, 1650 fr nl 415 fr wl John Richards Sur, Blk 125.	4-28-48	3874	3863- 3872	Strawn sd; Penn	P 21	41
Archer		Reno Oil Co's L. F. Wilson "Staley" 1 (OWWO), 330 fr s&wl, Blk 9, AT-NCL Sur.	4- 6-48	4005	3916- 3928		P 42; 46 wtr	42
Young		Howell & Howell's Mellis Prideaux 1, 3719 fr sl 776 fr wl of A. McMillen Sur.	4-27-48	2082	2974- 2985	Strawn sd; Penn	F 147	42.2
		TEXAS—District 9 (NORTH)—New Oil Pays						
Jack	Steed-Strawn	Warren Oil Corp's S. W. Leatherwood "A" 1, 467 fr nl, 330 fr el of E. S. Marley Sur.	2-10-48	4800	2885- 2901	Strawn sd; Penn	P 30	40
Jack	(Not designated)	Warren Oil Corp's E. F. Robertson "B" 1, 1263 fr nl 1412 fr el of M. J. Swann Sur.	3- 5-48	4793	4780- 4787	Caddo li; Penn	F 23; ⅜"	42
		TEXAS—District 9 (NORTH)—Oil Field Extension						
Clay	Acme	Fain & McGaha's C. W. Scaling "B" 1, 1320 fr nl 330 fr wl Sect 2, HT&B Sur, ½ mi n extension.	4-25-48	5840	5823- 5840	Ellenburger dolo; Ord	F 480; $\frac{7}{32}$"	44
Montague	Miller	R. B. Thrift, Trustee's J. H. Cross 1, 650 fr s&wl, Sect 16, Limestone CSL, 1 mi se extension.	4- 8-48	6210	6144- 6168	Bend cgl; Penn	F 1584; ½"	43.5
Wichita	Holliday, N.	Roy H. King's Mrs. Frances Morgan 1, 330 fr n&el, Blk 1, Margaret Ramsey Sur, ne extension.	4-18-48	3912	3880- 3911	Strawn sd; Penn	F 145; $\frac{1}{16}$"	43
		WYOMING—New Oil Pays						
Big Horn	Torchlight	Stanolind O&G Co's Orchard-Unit 2, sw ne se 24-51n-93w	4-16-48	3860	3362- 3636	Madison li; Miss	P 300	22.7
Park	Pitchfork	Husky Refining Co's Unit 5, nw nw se 11-48n-102w	4-16-48	4468	4219- 4250	Madison li; Miss	P 200	15.3
Park	Silver Tip	Seaboard Oil Co's Northern Pacific 64-33, se sw ne 33-58n-100w	4-23-48	5992	5925	Peay (Frontier) sd; U Cre	F 114; ¼"	47
Park	Silver Tip	Seaboard Oil Co's Northern Pacific 53-33, nw sw ne 33-58n-100w	4-30-48	9507	8496- 8524	Phosphoria (Embar li; Perm	F 576; 3 mln	44
Sweetwater	Werts	Sinclair Wyong Oil Co's Werts "D" 2 (OWDD), se sw ne 1-26n-90w	4-30-48	7193	6751- 6820	Madison li; Miss	F 1163; open	36

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

Amphibian Drilling GOES DEEP-SEA



Eight miles offshore in 50 feet of Gulf water, the completed platform, its drilling rig, and all the equipment needed to drill a well present a strange picture. Living quarters for a maximum of 54 men and water storage tanks are at the left. A standby boat is kept near the platform.

By ELTON STERRETT
Engineering Editor

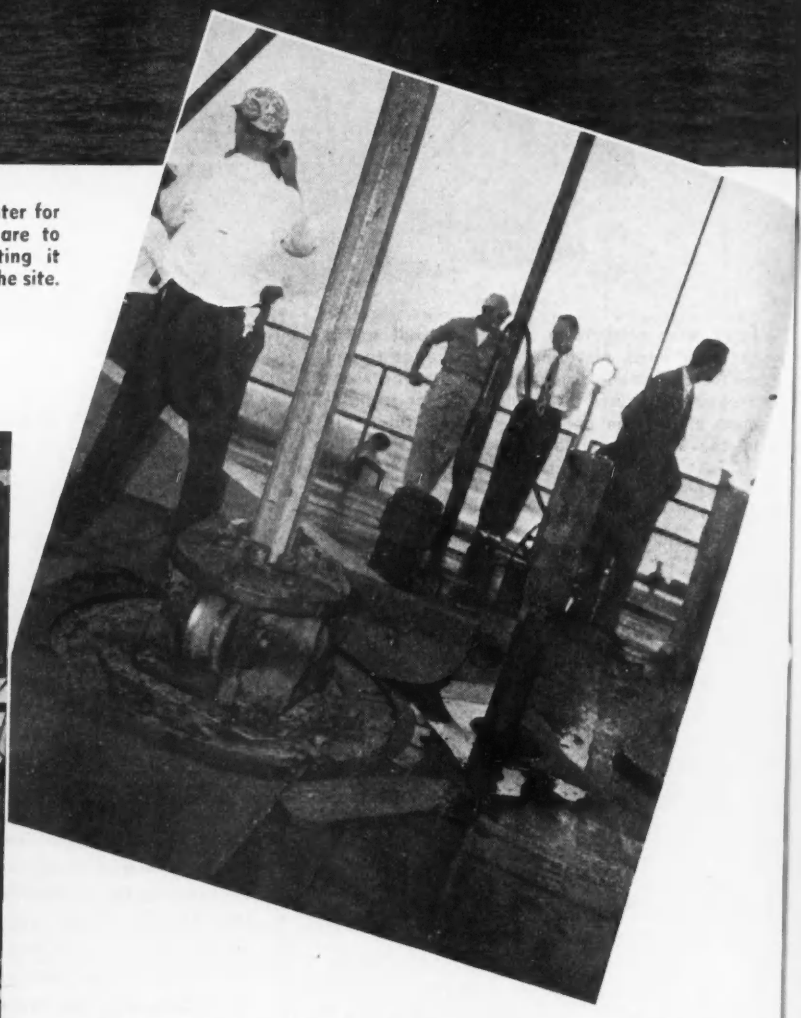
CONTINENTAL shelf oil reservoirs amid the deep salt dome area off the Louisiana Coast again promise to add to the nation's oil reserves as the Humble Oil & Refining Company's test eight miles offshore from Grand Isle penetrates zones with shows which will be tested after the well has reached projected depth and geophysical tests have been made. The well is drilling in salt at beyond 8100 feet (as of May 18th) and is routine insofar as penetration of the salt is concerned.

Carried on a platform designed to resist 35-foot waves and 125-miles-per-hour hurricane winds, the rig forms a separate community within itself. Living quarters on the platform provide accommodations for 54 men. A fresh water supply of more than 2500 barrels insures ample water even during a protracted storm, while seven 220-barrel tanks contain enough fuel for the diesels which power all units for over a week's run. At the end of a 12-mile run down Bayou Rigaud, through Barataria Pass and out into the open waters of the Gulf of Mexico, weather is perhaps the greatest hazard which the venture must face.

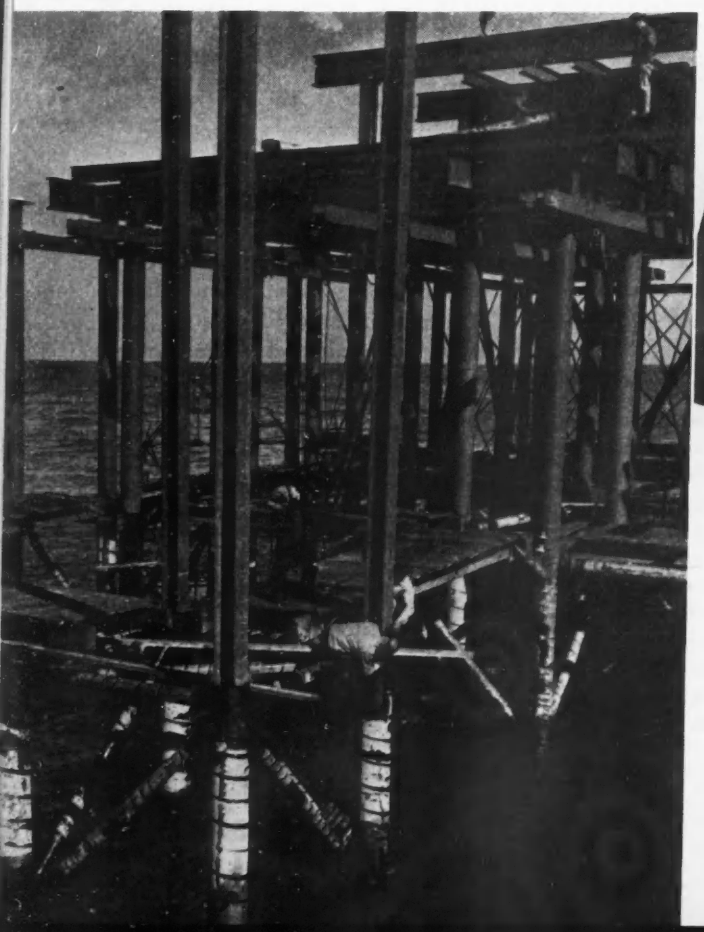
VIEWED DURING the inspection trip for editors and newsmen sponsored by Humble Oil & Refining Company May 16-20, the big offshore rig eight miles seaward from Grand Isle illustrates the painstaking care and thoroughgoing into the development of equipment which will effectively and safely reach the many salt dome areas between the low-lying shore and the 100-fathom line at the edge of the Continental Shelf.

To facilitate access to the rig, landing stages, of a unique and most practical design, are carried on three sides of the structure, so that a lee can be provided in which landing can be made with the thickly clustered piling and bracing of the rig structure to break up the seas and provide relatively quiet water. The transfer of personnel can be effected in all but severe weather, while bulk supplies, such as mud materials, cement, fuel, and water are taken "aboard" the rig only during calm weather. For this purpose the barge is moored alongside the platform on the shoreward side, where special provision is made to reduce chafing and impact as much as

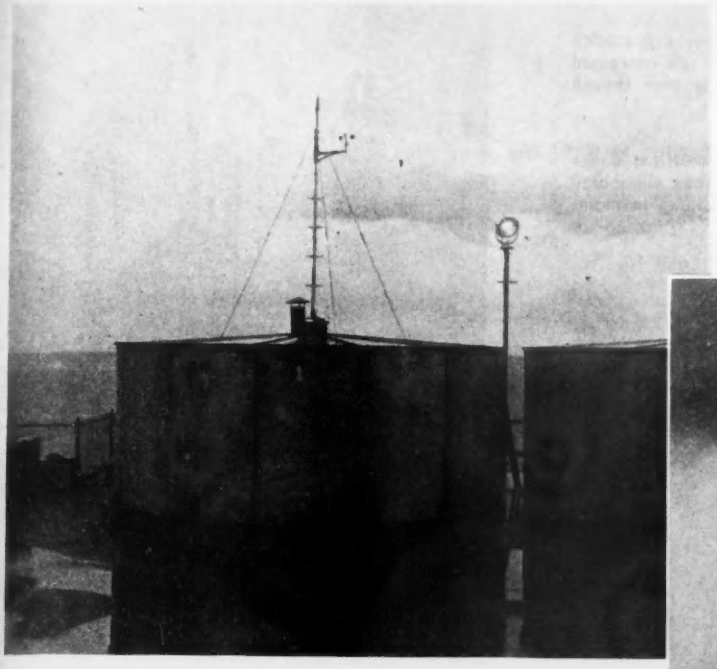
ABOVE:—Converted Navy equipment serves as construction center for erecting the platform. Here a template through which piles are to be spaced and driven is being upended preparatory to setting it through the ooze to firmer bottom below the 48 feet of water at the site.



ABOVE:—Rotary and mousehole snapped during inspection trip of newsmen and editors who recently were guests at the big offshore platform. The view is taken toward shore, but haze left after the waterspouts hides all view of the low-lying shoreline.



LEFT:—Closeup of one of the templates with some of the H-beam piles in place. These units were made up to 290 feet in length by welding on sections until the desired dimension was reached. Wrappings of glass fiber protect the template against corrosion and the formation of barnacle growth.



A weather station atop one of the fresh water tanks provides wind data and records the velocity at all times. Frequent exchange of weather data with shore installations assists in safe transfer of personnel, equipment and supplies.

A waterspout, one of 17 observed during an afternoon's storm, swirls toward the platform, roaring like a freight train, and picking up tons of water which, a few minutes later, cascade down over the rig, drenching everything. The storms failed to break over the rig, but have sufficient lift to snatch up ropes, wooden blocks and other unattached gear.

possible, and the bulk materials lifted aboard through a separate hoisting unit with a load capacity of ten tons. Oils and water are pumped aboard through hoses and distributed through separate manifolds to the storage systems. All fuel is stored on the lower floor of the platform, with water divided between horizontal cylindrical tanks on the lower deck and two low 500's above the living quarters.

Living Quarters

Located on the lower deck of the platform, the living quarters include rooms equipped to house either two or three men, with separate beds and lockers for each. The rooms are provided with individual ventilation units, and are well insulated against the noise and vibration of the drilling portion of the rig. A completely equipped galley adjoins the dining room, which in turn is flanked by the recreation room. Space is provided for the housing of all engineers, technicians and personnel of servicing or testing companies who may be on the rig, as well as for the supervising personnel of the drilling department who stay with the rig.

Above one portion of the living area are located the crew change rooms, equipped with showers and storage facilities so that there is no need for the men to wear mud-soaked working clothes into the living quarters.

Physical Rig Location

On a seismograph prospect, the site chosen for the test is in what is nominallv designated as 48 feet of water, under which is another 40-odd feet of unconsolidated silt, the upper portion of which has at the water surface little more supporting power than the water itself. So tenuous is this material that 80-foot long templates, formed from pipe and steel cross bracing, sank so rapidly into the material when they broke loose from the crane handling them that they were recoverable only after protracted grappling operations. Smaller material, when dropped to the ooze, was given up for lost and replaced rather than involve equipment while making a search.

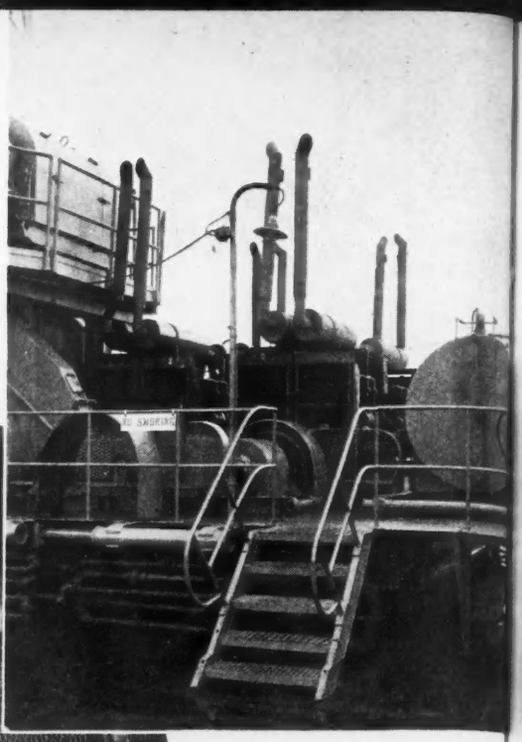
The templates used to locate the piles were set on end, and sank through their own weight until supported by the lower portion of the silt bed. Piling was driven through the templates to a depth of around 295 feet, being stopped just short of the first sand zone so as to allow for uniform settling of the platform as work progressed. Skin friction carries the entire load.

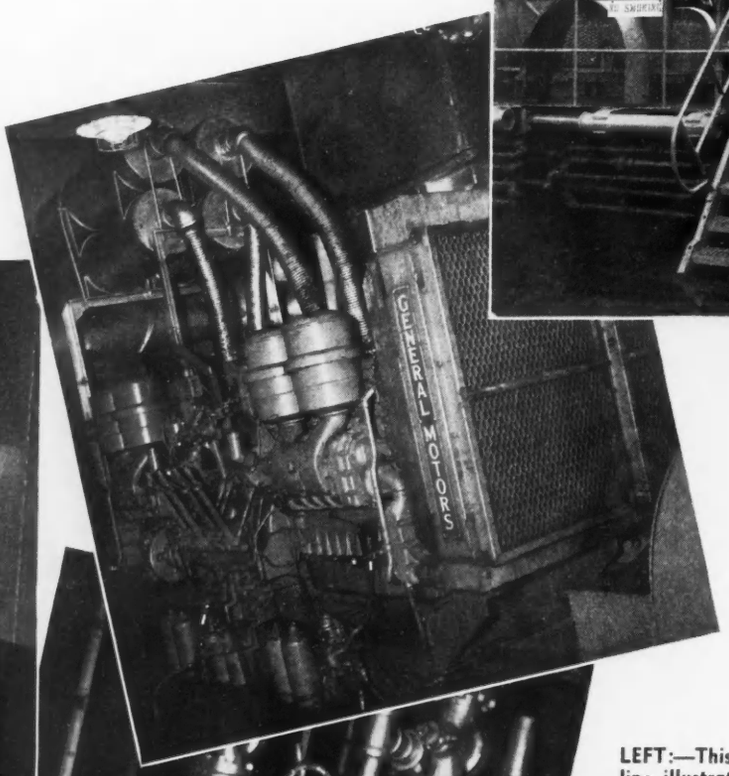
The first portion of the hole, to a depth of 290 feet, was made by driving a 26-inch pipe. This pipe was supported by approximately 200 feet of consolidated sea bottom, with the next 40 feet in the silt and the last 48 feet—below the water line—exposed to wave action of the open Gulf. Inside the 26-inch pipe was run 20-inch, to a total depth of 350 feet. These two were then cemented together, to the surface. A relatively rigid foundation for the further pipe program of the well was established through the method outlined, with a three-inch annulus of cement between the two casing strings to give stiffness to the unit and resist both bending and flexing under compression. Inside the 20-inch was run 13⅜-inch casing to a depth of 3500 feet. The bottom 800 feet of this string was cemented in the hole and then, with a bradenhead connection, cement was forced into the topmost 200 feet between the 13⅜-inch pipe and the 20-inch. This further reinforced the column effected by cementing the larger casings, and afforded the desired rigidity for mounting the longer strings.

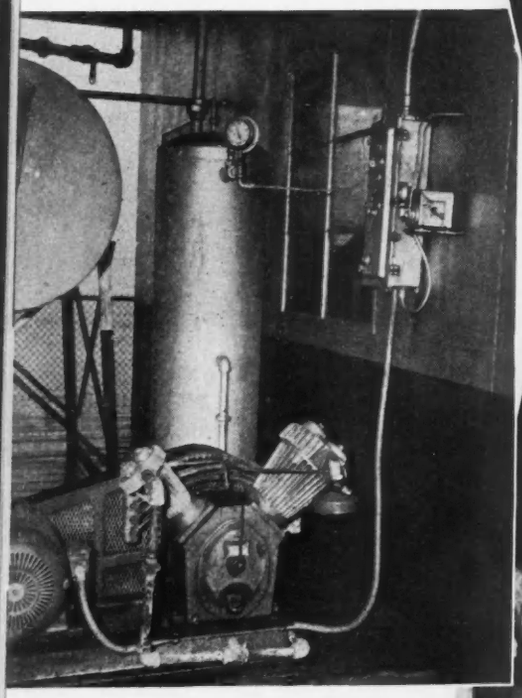
Forming a small community within itself, the rig is safeguarded against accident in every way possible. Gasoline as fuel is rigidly barred. All primary power is diesel, with a battery of four quads to provide the 1200 horsepower required for the drilling operations. The diesels are not direct-connected, but drive generators which provide current for the motors driving mud pumps, rotary table

RIGHT:—Four quads form the power unit for the drawworks drive. They are carried on a sub platform above the lower deck to facilitate servicing, and are self-contained with radiator, day tank and other equipment to enable them to operate even though shut off from the remainder of the rig.

CENTER:—Close-up of one of the pump quads, showing grouping of mufflers under floor above. Exhausts are carried to the edge of the floor and gases thus eliminated from the covered area. Blast is from the engine through the radiator, aiding in maintaining desired operating temperatures.

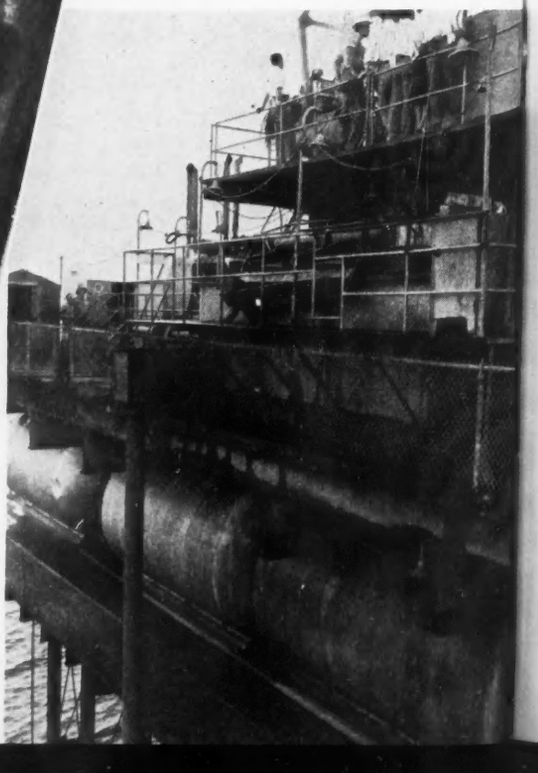






ABOVE:—A two-stage compressor furnishes air for the many requirements of the rig. As with other auxiliary equipment, it is driven by a motor which draws power from the rig distribution system. Pressure controlled, the unit operates only when air is withdrawn from the storage tank.

LEFT:—This section of mud suction line illustrates, through the five flexible couplings within the area shown, how carefully plans are laid to absorb any distortion which wave action may impose on the structure and through it, the equipment mounted thereon.



RIGHT:—End tanks of the rows which contain fuel and fresh water. The units, as with much else on the rig, are converted war equipment, being salvaged pontoon floats. The square box with dependent pipe is the cuttings disposal system, the waste being flushed from the trough edging the shale shaker by a high pressure jet of sea water, and carried through the hopper into the 12-inch drop leg for the first part of the long drop to the water. The drop pipe is curtailed above estimated wave height to avoid storm damage.

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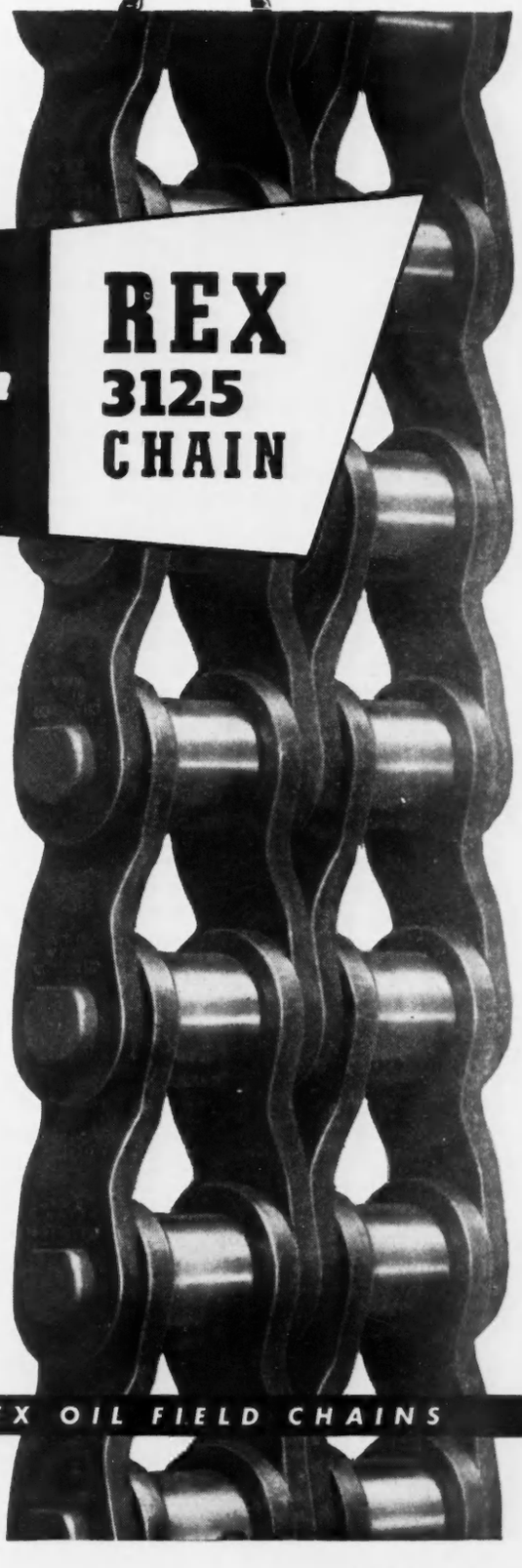

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This is Humble's production base on Grande Isle, Louisiana. Docks and boat slips in the foreground are on Bayou Rigaud; the Gulf of Mexico can can be seen in the background. Tall structure near office building is not an oil well, but a radar tower.

and drawworks. Interlocking circuits enable power to be concentrated where needed, and provide for quick changeover from one unit to another. Separate generating units, in duplicate, furnish current for the rig and living quarters. All wiring is carried within flanges of the steel beams forming the structure and circuits are thus protected against wind and water damage.

A salt water-lime mud is used, reducing the demand on fresh water storage, sea water being drawn into a storage tank and added thence to the mud stream as needed through separate pump system. This same sea-water system provides the means for removing cuttings. A V-shaped trough, at the lower edge of the shale shaker frame, collects cuttings while a high pressure jet of sea water, traversing the trough, sweeps material into a hopper resting atop the 12-inch vertical disposal line. This line terminates above the calculated wave crest line and permits the material to drop freely into the Gulf, where the fall through 48 feet of water effectively disperses the material and prevents the formation of a mound which might otherwise affect the stability of the bottom around one or more of the pilings.

Sewage and other waste also find their way to the water below the rig, outflow piping being carried down the framework so as not to interfere with the transfer of either personnel or material, no matter from which direction wind and sea might be running.

Although the rig floor, even under maximum vibration load when coming out of the hole with pipe, is much more steady than that of a similar land unit, special provisions are made to absorb possible deflections and changes in the structure under wave and wind impact. Mud suction lines, for instance, are equipped with double flexible couplings and short connecting spools. Mud, water and fuel lines are equipped with swings at manifold tie-ins, and frequent check valves prevent loss of fluid in case of line breakage or valve failure.

Ingenious Landing Stage

Typical of the special designing involved in the conducting of oil well drilling on open waters is the means developed for transferring personnel to and from the 83-foot twin screw tenders used between the rig and the marine terminal on the inshore side of Grand Isle. Usual rope ladders or gangways were unsuitable, due to the constant change in elevation between whip and rig in all but the quietest weather. Various setups were tried, and out of them was developed the system now in use. A pivoted gangway is suspended from the rig, with a universal connection which allows motion of the walk section laterally and/or vertically. At the outer end of this gangway is a ladder, equipped with handrails. The bottom of the ladder terminates in a point, where is attached a rubber sphere. The tenders carry in their bows sockets which match with the gangway spheres, and which are equipped with a cleat around which may be looped the two steadying lines attached to the base of the ladder.

When a tender approaches the rig a line is made fast to its bow, and the engines then reversed to provide tension on the line and maintain the bow at a given distance from the rig structure. This distance corresponds to the lateral length of the walkway, so that the socket in the bow maintains a fixed distance from the rig. The bridle by which the walk is suspended maintains the walk against tipping, while rolling or pitching of the tender is absorbed by the rubber ball mounting. The ascent or descent of the ladder portion is a feat which involves considerable agility in wet weather, even in the lee formed by the structure, and it frequently includes a salt shower as waves slap the bow of the tender and spray dashes upward along the ladder.

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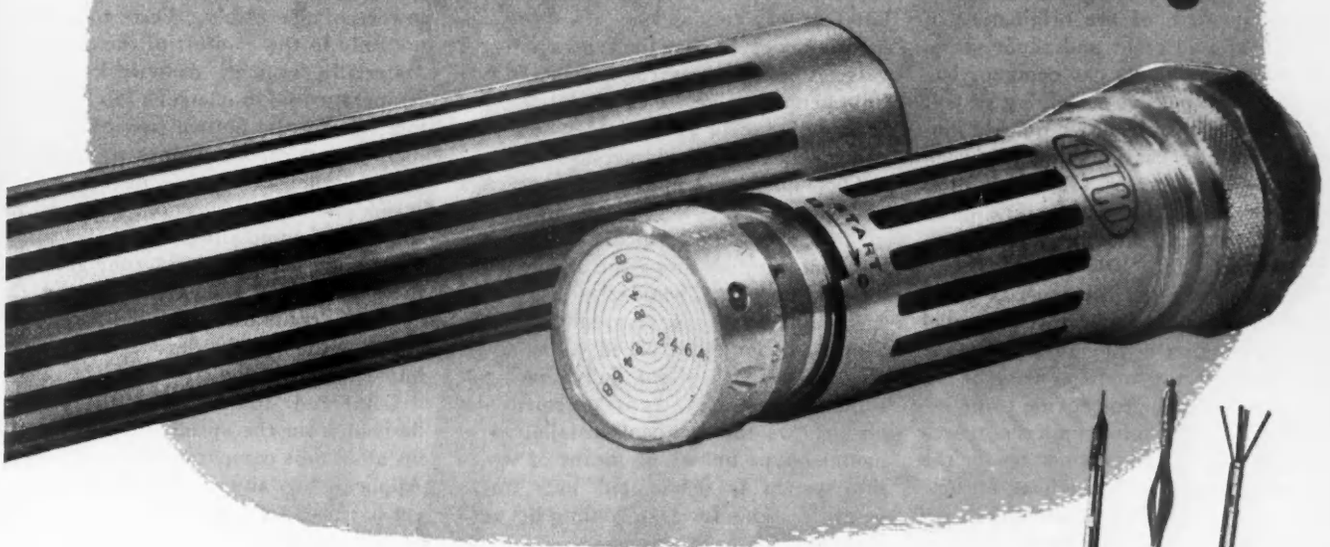

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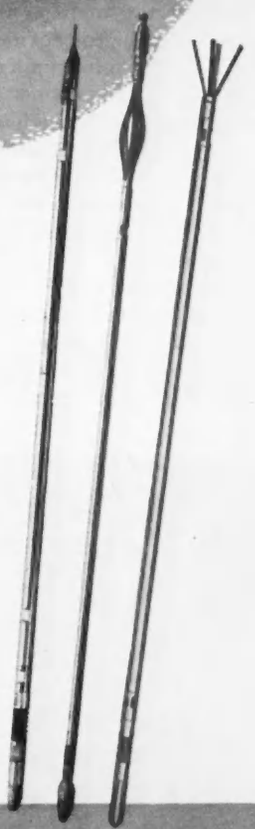

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FIRE HAZARD CHECKED by UNDERFLOOR SYSTEM

by GILBERT M. WILSON
Staff Writer

ON A DRILLING rig the possibility is always present of fire originating in the cellar and adjacent underfloor areas. To combat this danger one company has devised an inexpensive sprinkling system which may be broken down quickly into small units for easy hauling between locations. The nozzles are of the fog type which emit an unusually fine spray that is particularly effective in smothering this type of fire.

The sprinkling system consists of 20 nozzles positioned along three parallel lines of piping extending the full length of the rig floor, the lateral spacing of the heads being such as to provide complete blanketing of the entire underfloor area with spray. As special protection for the area surrounding the casinghead fittings, sprinkler heads were mounted at each corner of the cellar. The system is turned on during those times when it is believed gas may escape or during completion operations.

To insure equal water pressure and volume at all points in the system, each line starts with three-inch pipe and tapers to two-inch at the distant end. The three lines, while operating in parallel, are fed by a common header, the latter in turn coming out of a short six-inch line located near the central control valve. This main control, a quarter-turn, full-opening valve, is located near one corner of the rig (Figure 1) where it is convenient and quickly accessible.

The piping system is supported on a number of simple loop hangers made of sucker rod material, which are secured at frequent intervals along the underside of the derrick floor. The nozzles themselves are mounted in fittings brought out horizontally from tees spaced at intervals along the length of the individual lines. Figure 2 illustrates this arrangement and also shows the frequent installation of hammer-type unions by means of which the system is dismantled into truck-length sections for easy hauling between locations.

Temperatures Lowered

In addition to the fire protection element which the sprinkler system provides, there also exists another valuable feature. In areas subjected to extreme summer heat, it has been found that by turning on the sprinkler system, temperature on the drilling floor can be lowered appreciably. This contributes not only to the comfort of the crew, but materially reduces drawworks engine temperatures. On one such job last summer, during the hottest part of the day, temperature of the engines was reduced by as much as seven degrees when sprinklers were turned on. Hot air, instead of accumulating under the rig, is cooled and kept moving by the action of the fine spray. The water lost by the system is comparatively small, and compared to the benefits derived, is of minor importance.

Compared to the over-all benefits derived from the sprinkling system, the installation is comparatively inexpensive. Applicable to any drilling or work-over rig having an elevated derrick floor, the system takes up little or no space that might be usable for other equipment, and the time required to hook it up or break it out is small. The header and valve phase of the system is permanently mounted inside one of the substructure bases, and it is necessary only to break out several quick-acting unions to disassemble the three lines.

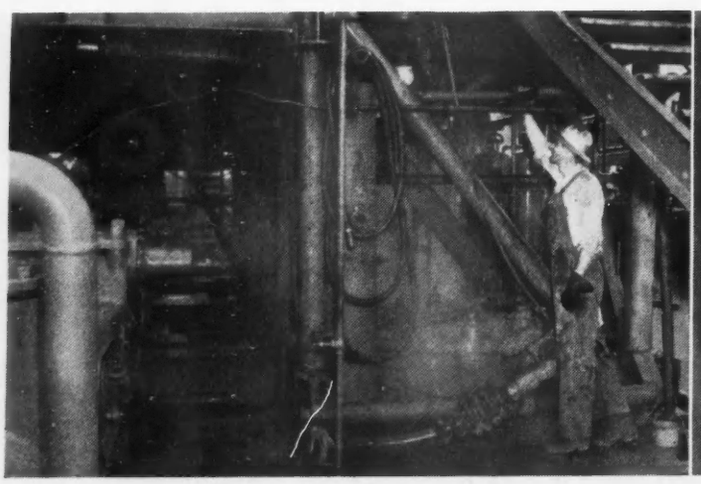

FIGURE 1. Central control valve for the sprinkling system is conveniently located at one corner of the rig just inside one of the substructure bases where it can be operated quickly in case of emergency. Note fog-like spray emerging from beneath floor after valve had been open for only a minute or two.

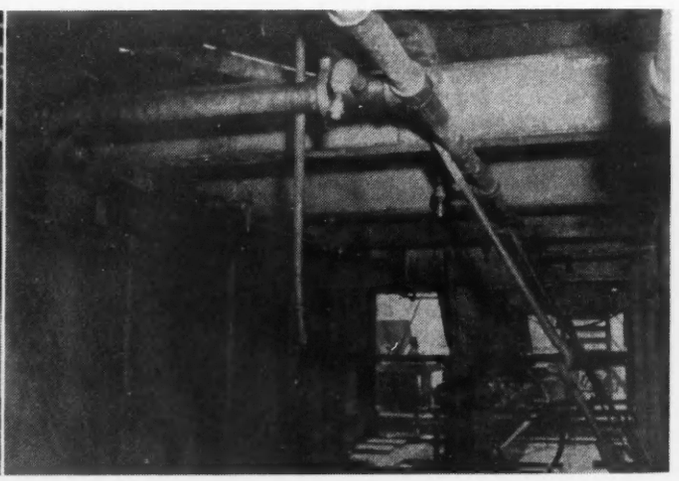

FIGURE 2. Underfloor view of two of the tapered sprinkler lines showing position of sprinkler heads. Cellar in background is provided with four nozzles as extra protection against fire at that point. Note hammer-type unions which, after being broken out, permit piping to be lifted off sucker rod hangers and carried out in convenient lengths.

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Completion Methods in the Eastern Interior Coal Basin

By EMMETT C. WELLS, JR.

BECAUSE OF THE frequency of dual completions in the Illinois Basin, operators are confronted with problems in well completions which differ from those in conventional areas where production is obtained from a single horizon. The writer presents current completion practices in that area.

COMPLETION methods practices in the tri-state territory designated as the Eastern Interior Coal Basin have undergone considerable change since 1937. Oil is being produced from at least 15 different sandstone pays plus seven or eight separate and distinct porous zones of the Ste. Genevieve formation and porous zones in the Devonian and Trenton limestones. The more common oil horizons occur at subsurface depths of 1300 to 3400 feet.

Methods employed in single sand completions are generally classified as open hole and cemented blank casing. Often a combination of these two types is employed in multiple zone completions. As would be anticipated in an area where a number of prospective oil zones are present, but where their occurrence is often erratic, many wells are completed as multiple zone producers. Multiple zone completions as practiced in the Basin Area are those where two or more pay zones, exposed in a single well bore, are produced together, usually by pumping This discussion will give a brief history of the various completion procedures employed by the operators in the Basin states and a description of the present methods in both sandstone and limestone formations.

Casing and Cementing Programs

Successful cement jobs are so closely associated with successful water-free completions that it is appropriate to discuss cementing methods followed by some operators with good results.

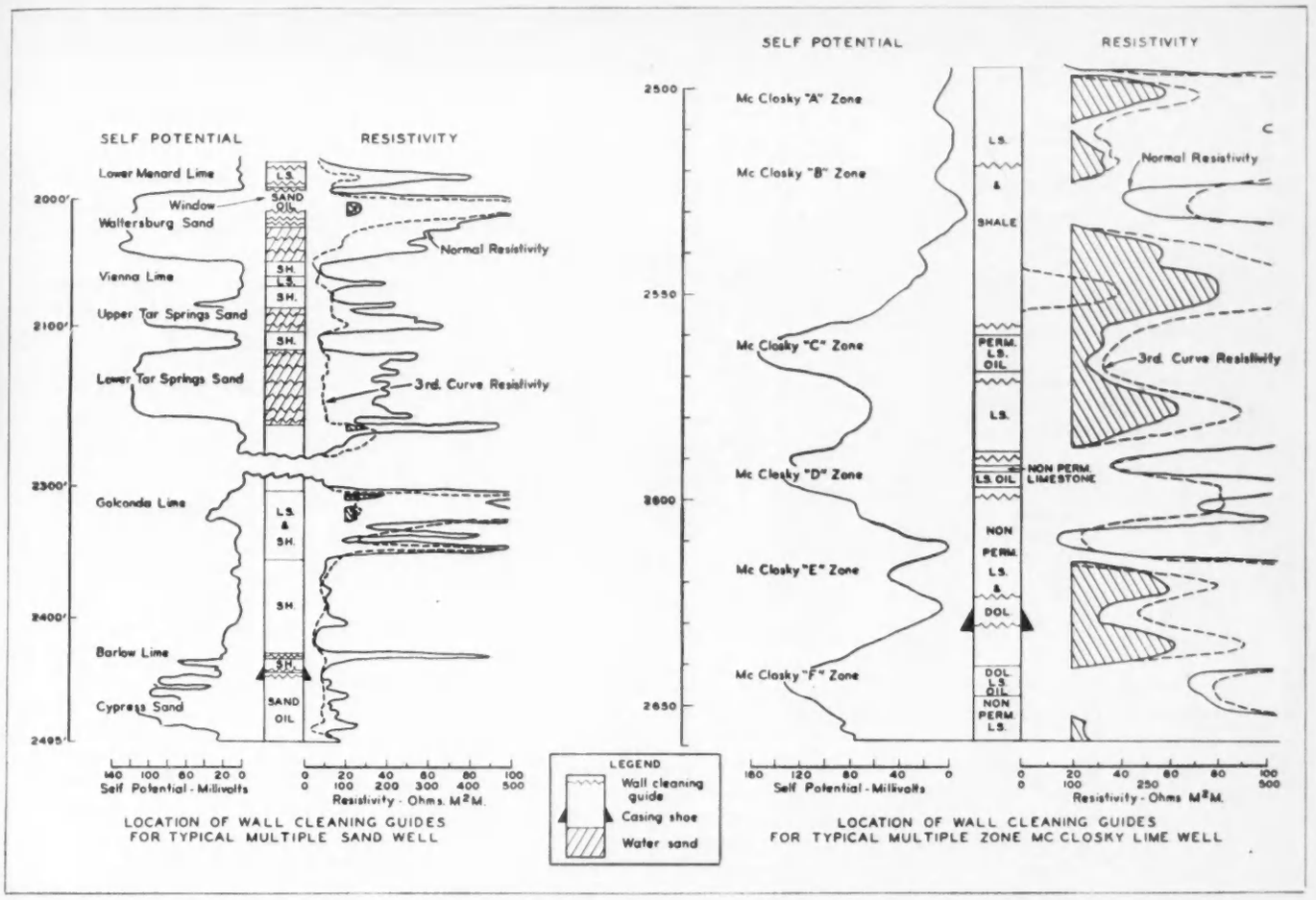
The size of the hole drilled and the casing program employed by the different operators varies from a nine-inch hole with a seven-inch outside diameter oil string to a 6¾-inch hole in which 4½-inch OD casing is set. In the majority of multiple zone completions, seven-inch OD is used, while in single zone and limestone producers, 5½-inch OD casing is more common. Apparently the variations in hole size and casing size have little effect on successful cement jobs.

The cementing problems commonly associated with deep drilling are seldom encountered, but because of the relatively low reservoir pressure and the nature of the productive sandstone and limestone, it usually is desirable to use nitroglycerin shots in sand and acid treatments in limestone if successful completions are to be made. Therefore, it is often necessary to insure a cement seal for some distance above the casing shoe which is sound to the extent that application of nitroglycerin shots or acid treatments to the various exposed zones does not result in the need for squeeze cementing. The presence of water-bearing horizons between the upper sand and the zone to be completed below the oil string has always made the cementing of casing strings in multiple zone wells a difficult problem. Obviously, the thicker, the more numerous, and the closer such water sands are to the window, and the greater the distance between the window and the casing shoe, the more difficult it becomes to obtain a satisfactory primary cement job, one which results in a water-free completion without resorting to squeeze cementing. Considerable experimenting has been done by many operators in an effort to improve primary cement jobs and in general, the success frequency has been increasing. Table 1 reflects the frequency of squeeze cementing in the Basin area, 1940 to 1946, inclusive.

The cementing problem first became acute in southern Illinois where the intervals between producing zones were as great as 700 feet in some pools. In order to combat this condition, one operator adopted with encouraging results, the practice of spudding the pipe while cementing in an attempt to prevent channeling. This practice was used by another operator with the addition of equipping the oil strings with wall-cleaning guides, and even better results were obtained. The wall-cleaning guides are welded to the outside of the casing string, and normally are spaced two immediately above the casing shoe, others approximately ten feet apart through water-producing sands between the casing shoe and window, and two each about three or four feet above and below each casing window. Some operators prefer casing centralizers to the wall-cleaning guides. A mud control

About the Author

EMMETT C. WELLS, JR., was graduated from Louisiana State University in 1936 with a B.S. in petroleum engineering. He went to work for Standard Oil Company of Louisiana, Production department, and in 1939 was transferred to Magnolia, Ark., where in 1940 he was made district engineer for Louark Producing Company (formerly Standard Oil of Louisiana, Production department). When Louark merged with The Carter Oil Company in 1941, Wells was employed by them until he entered the Army in 1942. Upon his discharge in 1946 he returned to Carter and was sent to the Eastern Division office at Mattoon, Ill., as senior engineer. He became assistant division engineer of the Eastern Division in August, 1947.



Two typical multiple zone well logs in the Illinois Basin Area showing the location of wall cleaning guides with reference to the formations present.

program was also inaugurated by one operator, primarily to improve cement jobs, but one whose characteristics were no different from those normally desired for efficient drilling purposes. Usually mud is mixed immediately above the first prospective producing zone and conditioned to a 15 cc. API water-loss index or less. In field practice it has been found that this particular water-loss index insures a filter cake of 3/32 inch or less, and mud of this quality can be readily maintained with equipment and chemicals available without a great deal of extra supervisory time or money. It is believed that when a relatively thin filter cake is obtained, the plunger action of the cement aided by the wall-cleaning guides and spudding the casing will clean the hole and permit cement to become securely bonded to both casing and formation. Mud viscosity is usually reduced to about 38 seconds before running casing. While the hole is being circulated before cementing, the casing string is moved in the derrick through a distance of 20 to 30 feet. The casing remains on the casing seat while the cement is being mixed, but while pumping the plug after cement is started around the shoe the casing again is spudded as rapidly as possible, as long as safety permits. When the pipe begins to lose weight it is spotted on the casing seat and remains undisturbed for the remainder of the job. From five to ten barrels of water containing 100 pounds of quebracho are pumped ahead of the cement and the slurry is gradually built up to a weight of approximately 15 pounds. A 3 percent gel cement is used and the relatively light slurry has been found necessary to prevent execssive pump pressure and to eliminate a tendency of the pipe to stick or pump out of the hole.

The amount of cement used varies among the different operators from 100 to 500 sacks per job. The average volumes used are 250 to 300 sacks, which is usually sufficient to insure a seal well above the uppermost pay zone.

The use of the above described methods has been attended with water-free success frequencies up to 97 percent on multiple zone completions. Casing shoe leaks are practically eliminated if these methods are followed.

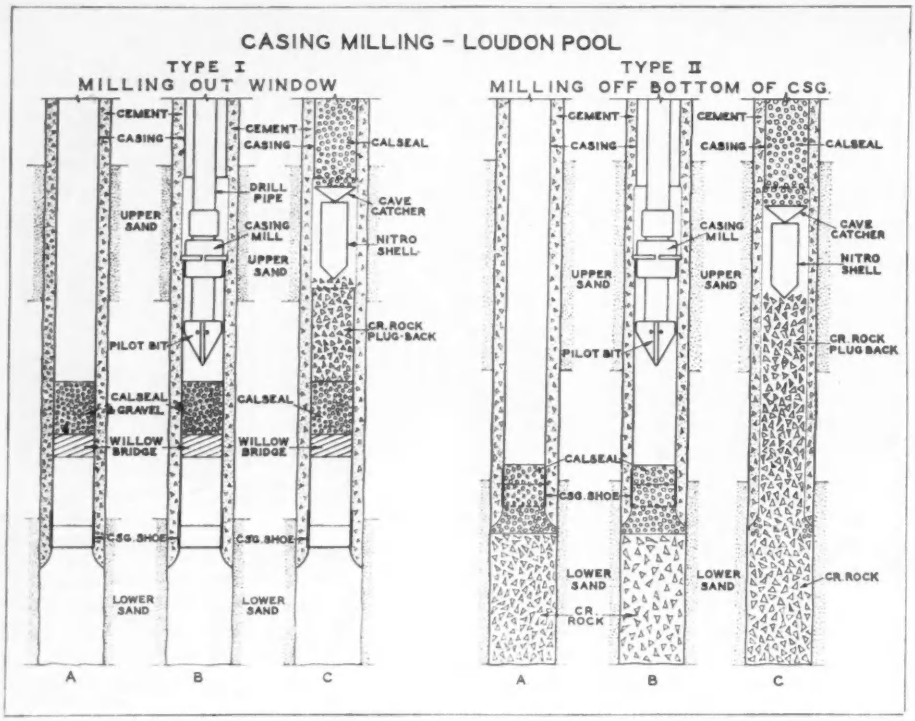
It also has been determined that satisfactory cement jobs reduce damage resulting from shooting in the open hole below the casing or in a window.

The open hole method of completion is the most common where a single sand is to be completed and where the hole is bottomed in the pay zone. This method constitutes setting the casing above the producing zone and completing the well in the open hole without benefit of a liner. Shooting is accomplished in the conventional manner.

The cemented blank casing method, as the name implies, seals off the producing zones necessitating some method of exposing the producing sand. Perforation by gun or casing ripper is used where the upper sands have sufficient permeability to produce through perforations, but the nature of the vast majority of the sands encountered in the Basin area requires nitroglycerin shots for effective completions. This makes an open window desirable. The window may be removed by milling, shooting, or by the use of chemicals, thus permitting shooting of the exposed sand face with nitroglycerin. The cemented blank casing method is used primarily where the hole has been bottomed below the productive zone and it is necessary to plug

TABLE 1
Frequency of Squeeze Cementing
Illinois Basin Area

YEAR	Total Number Oil Strings Cemented	Total Number Squeeze Jobs	Squeeze Cementing Frequency Percent
1940	2,846	406	14.3
1941	2,462	564	22.8
1942	1,107	281	25.4
1943	1,243	328	26.4
1944	1,689	315	18.7
1945	1,682	243	14.4
1946	1,901	247	13.0



Drawing illustrating the milling of steel casing strings in the Loudon Pool, Illinois.

back and complete in the upper pay section, or to open more than one pay zone into a single well bore.

Multiple zone completions have been widely adopted as a result of the economics involved. By this method wells with more than one productive sand present can be developed and operated for approximately 60 percent of the cost for single wells to each sand. The presence of several sands of similar characteristics in the same well, requiring initial nitroglycerin shooting for efficient production, resulted in windows being opened in the upper zones for multiple zone completions.

The first installation of a removable casing window occurred in September, 1938. A corrosion resistant aluminum alloy tube of reduced size was inserted in the casing string opposite the upper sand and cemented. Removal of the section was made by the use of a pilot type five-way bit and was followed by a rotary wall scraper preparatory to shooting and testing. The lower sand was then completed without difficulty using conventional methods. Prolonged caving of the upper sand around the top of the window, partially the result of an absence of protective shoes at the top and bottom of the window, resulted in excessive maintenance costs and the job was regarded as defective despite a successful pipe removal. Subsequent multiple sand completions employed two heavy casing shoes having an API thread to receive the alloy tube. The alloy tube was of the same size as the casing string, making it possible to complete the lower sand first. These sections and the cement behind them were removed with an expanding rotary or cable tool reamer. Use of this method spread rapidly until its use in the Basin became widespread.

During the course of the method's evolution, the employment of an acid-soluble magnesium alloy casing for window sections also came into favor by one operator, simply because of local conditions. The physical properties are lower than those of the aluminum alloy and its lack of corrosion resistance to sodium chloride solutions is such as to render it virtually useless as a window section to be preserved for any considerable time after installation. Removal of these sections was accomplished with acid, by cutting, or by shooting. Its use today is negligible.

Wartime non-availability of the special removable alloys made it necessary to adopt other techniques. As a substitute for aluminum and magnesium alloys, thin-walled sections of low carbon content steel pipe were set opposite the upper pay zones. Removal was accomplished with expanding rotary or cable tool reamers or by shooting with nitroglycerin, after densely gun-perforating the pipe at both ends of the window and sparsely through the section. Outright milling of windows through regular steel oil strings, a method already in use to open windows in older wells not provided with special alloy sections, was also employed by some operators.

Another wartime expedient made use of casing the well in two sections. The lower section, extending from the bottom of the upper zone to the top of the lower zone, was run on drill pipe or tubing, cemented and released with a backoff tool. The hole was conditioned and the upper section run to the top of the upper pay and cemented, leaving a window between the two sections. Also used was a J-tool arrangement connecting the two sections, whereby the entire casing string was run in the hole and cemented in two stages. After cementing the lower section the tool was released, the upper section raised the desired distance, the hole conditioned, and the upper section cemented. As was mentioned, these were wartime expedients, and cannot be compared with other methods for efficiency, and have since become obsolete.

With the arrival of the aluminum alloy back on the market in 1945, commercial services for removal of aluminum alloy with a solution of hydrochloric acid or by a water solution of caustic soda with sodium nitrate became available. The acid contains a starter to decrease the initial reaction time, and an inhibitor to minimize the action on steel. The caustic nitrate solution reacts with the alloy to form water soluble, sodium aluminate and ammonia gas.

It is placed in the well by means of a dump bailer in batches. Each batch is bailed out before fresh chemical is added and three to five batches are required to remove the average window. A theoretical temperature of 1100° F. is generated by the chemical reaction, and this temperature breaks up the cement in the window.

The present-day method of multiple zone completions for sand wells has become more or less standardized in the Basin area. A few wells have as many as four producing sands open into a single well bore with three producing through windows and one from open hole, but the most common well has one sand producing from the open hole and one through a window. For multiple zone completions the casing string is made up with the aluminum alloy sections spaced opposite the prospective producing zones.

Cable tool rigs are used almost exclusively for completion work in sand

TABLE 2

History of Multiple-Sand Cementing by One Operator—Years 1941-1945

YEAR	Total No. Of Jobs	No. of Successful Jobs	Success Frequency	Type of Cementing Program
1941.....	10	5	50%	Conventional
1941-42.....	18	17	94%	Mud control, wall cleaning guides, pipe worked
1942-43-44....	21	11	52%	Mud control, pipe worked occasionally, centralizers on some wells
1944-45.....	64	62	97%	Mud control, wall cleaning guides, pipe worked, cement slurry weight controlled

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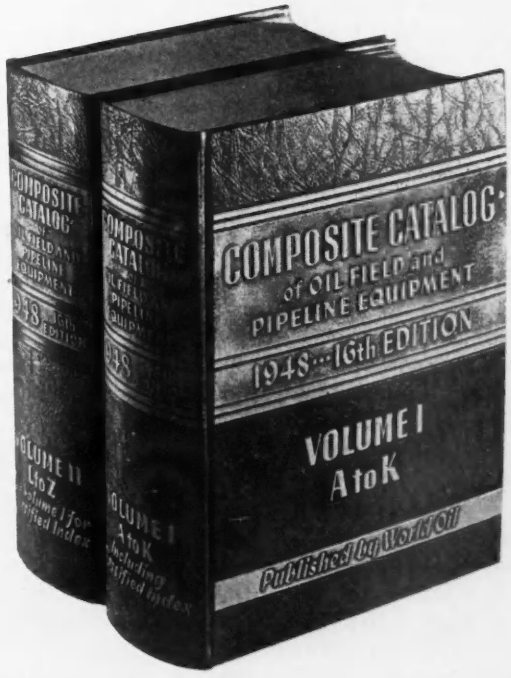

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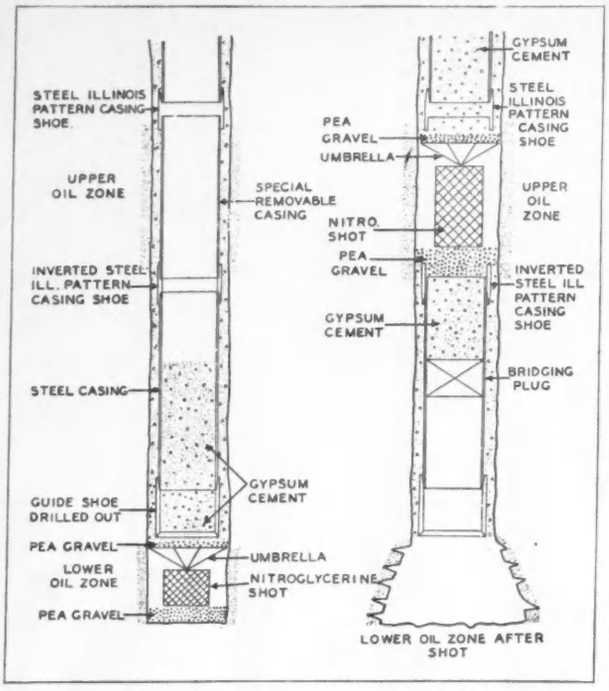
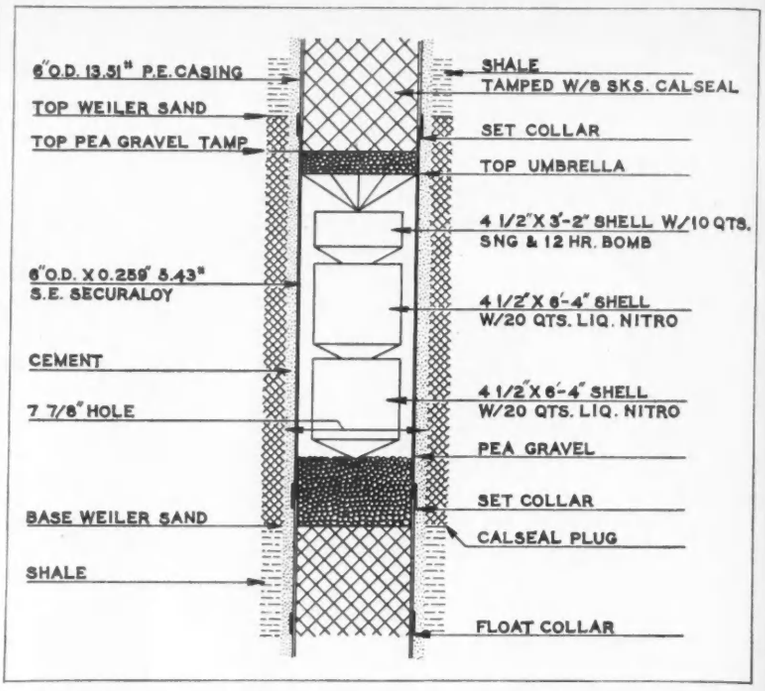


A method of tamping employed in the Illinois Basin Area.



Method of removing drillable casing by shooting with nitroglycerin in the Loudon Pool, Illinois.

wells. After the oil casing string has been set, the rotary tools are moved off and the cable tools moved on location. Cable tools permit exclusion of drilling fluids from the face of the formation during completion work. The bottom zone is generally completed first. The hole is bailed dry and if the casing is set on top of the lower zone, the plug is drilled, the well cleaned out and a natural production test obtained. The sand is then shot with from two to ten quarts of nitroglycerin per foot, depending on sand condition, the average approximating three quarts per foot. The hole is then cleaned out and the zone tested to establish initial potential.

Before opening the lower window a bridging plug is set from 20 to 40 feet below the window. The window is then removed with caustic, acid, or by perforating and shooting. After cleaning out the window a natural test is obtained before shooting. Shot density is approximately the same as for shooting in an open hole. The well is cleaned out to slightly below the window and the initial potential of the zone established. If additional windows are to be opened the same procedure is followed for each. When testing has been completed on the uppermost zone, the bridging plugs are drilled out, the hole cleaned up, and the well placed on production.

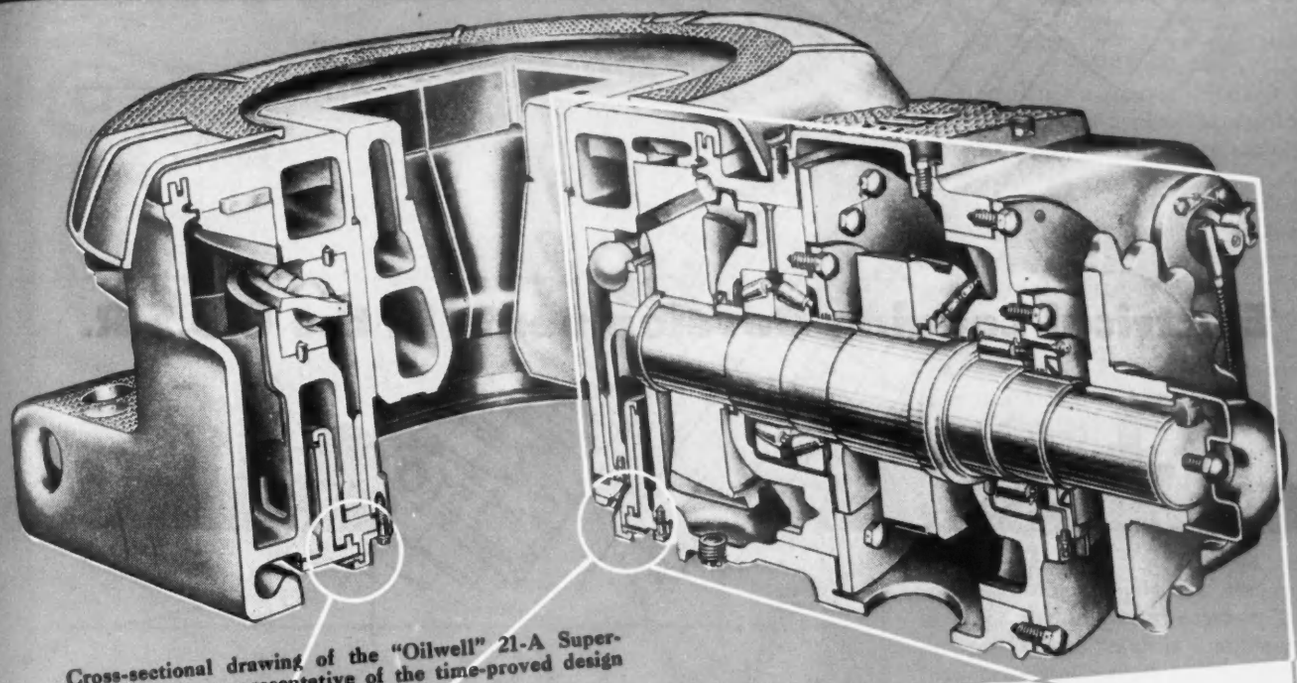
Methods of removal of alloy windows are divided among caustic nitrate solution, gun perforating and shooting, and acidizing. Many completions, probably well over half, use the caustic method, and nitroglycerin shooting is next in popularity. The perforating and shooting accomplishes the dual purpose of window removal and shooting the pay zone. This operation is slightly lower in cost, but if another producing zone is below the window, there is always the hazard that splintering metal might create an obstruction in the window, and prevent access to the lower zone.

Although aluminum alloy is used almost exclusively for window sections, some thin-walled, low carbon content steel pipe is still used. These sections are removed primarily by perforating and shooting.

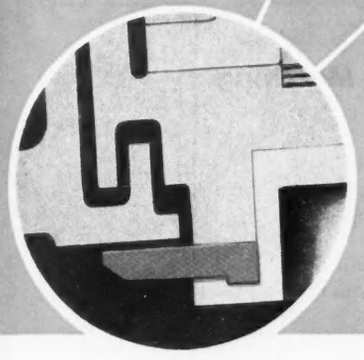
Tamping methods for nitroglycerin shooting are practically uniform for all operators. A gypsum cement is used in conjunction with pea gravel and water as a tamp. A few operators use a quick-set neat cement instead of the gypsum cement but they are in the minority. In shooting below the casing in open hole pea gravel is used to space from the bottom. The shot is placed covering the desired interval but maintaining an average distance from top of the shot to the casing shoe of five feet. Pea gravel is again used to fill up to about two feet below the casing shoe, and the cement is dumped to fill an additional 40 to 80 feet in the casing. Height of the cement depends on the thickness of the sand sections immediately above the producing zone. Water is then used to completely fill the hole. A time bomb is used for detonating the shot. In window shooting the same procedure is followed except that the pipe between the bottom of the window and the bridging plug is filled with cement. The shot is spaced an average of five feet from both window shoes.

Limestone completions differ considerably from sand well methods. Rarely, except during the final stages of depletion of the lime zone, are a sand and lime produced through a common well bore. However, there are many instances in which upper sands are cased off by removable sections in lime wells, where it would be uneconomical to drill separate wells.

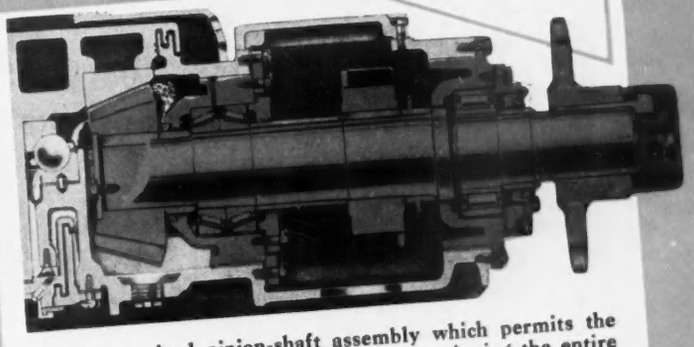
Most limestone wells produce from a single zone, but in areas where the Ste. Genevieve formation is productive, as many as three closely spaced zones may produce in a single well. The more common completion practice is to set casing through the pay zone, which is exposed by gun perforating. To obtain efficient productivity most limestone zones require acidizing. Where more than one producing zone is present an effort is made to acidize and test individual zones selectively, either by bridging plugs or through the use of packers. The lower zone is normally opened and tested first, followed by the next higher zone until all zones present have been tested. When all zones have been opened and tested, they are produced together in the common well bore. Casing is sometimes set on top of the pay zone when only one producing zone is present. The open hole is acidized in this type completion. A method of selective acidizing, the electric acid pilot, has been developed, but its use in this area has been limited. Infrequently in multiple zone lime completions, water producing zones are located in the short interval between the pay zones. For successful water-free completions, without resort to squeeze cementing a sound cement job must be insured.



Cross-sectional drawing of the "Oilwell" 21-A Super-Speed Rotary, representative of the time-proved design features of all "Oilwell" rotaries.



A sealing ring designed with a flexible lip which will bend upward and form a tight seal against the oil-retainer ring when struck by a stream of mud.



Easily serviced pinion-shaft assembly which permits the replacement of either bearing without stripping the entire pinion shaft.

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Flexible Sealing Ring—This ring attached to the bottom of the hold-down ring is an additional safeguard which prevents mud from below from getting in through the labyrinth to the base enclosure in event of a blowout.

Positive Circulating Oilbath Lubrication for the main bearings, gear train, and hold-down bearing, is effective at all speeds. This constant flow of oil is an assurance of longer gear and bearing life.

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Maximum Recommended Drill-Depth .....Feet	9000	9000	13000	17000	17000
Maximum Recommended Table Speed .....r.p.m.	500	500	500	1000	400
Gear Ratio	3.28:1	3.28:1	3.82:1	2.61:1	3.84:1

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UNITED STATES STEEL

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Electrical Logging Developments in the U.S.S.R.

Part 5

Interpretation of Resistivity Data by Partial-Curve Matching

By HUBERT GUYOD
Well-Logging Consultant, Houston

THE determination of a quantity from a family of curves by interpolation between curves usually can be done with accuracy and in a simple manner. It is also relatively easy to position correctly a given curve within a corresponding family of curves when only one variable is involved. An example of this case is the use of two-medium resistivity departure curves (non-invaded formations).

On the other hand, the problem of interpolation or of curve matching is considerably complicated when there are two variables, and it is practically insoluble when three or more variables have to be considered.

Limitation of Full-Curve-Matching Method

A typical example of a problem involving three variables is the application of departure curves to the interpretation of an electric log made in mud-invaded formations. The three variables are D/d, R_i/R_m and R/R_m. The understanding of the influence of these factors within the usual range of values found in the field necessitates a relatively small number of curves. For example, curves calculated for five different values of D/d, six values of R_i/R_m, and perhaps ten values of R/R_m, i.e., a total of 300 curves, suffice to establish accurately a departure curve corresponding to any usual predetermined condition. On the other hand the reverse process, namely the determination of D/d, R_i/R_m and R/R_m by the curve matching method described in the preceding article, necessitates a considerably larger number of curves arranged in adequate charts if a reasonable accuracy is desired. It is doubtful, however, that practical charts can be prepared because functions involving simultaneously three different variables cannot be conveniently presented in a manner adapted to the conventional superposition method of interpretation.

THE DATA on electrical logging summarized in the preceding articles, as well as some developments in surface exploration, suggest new approaches to the problem of electric log interpretation. One of them is outlined in this article. Although only little work has been carried out on this idea so far, the results obtained are encouraging. The method is presented here with the hope that it will be developed by an organization having adequate research facilities.

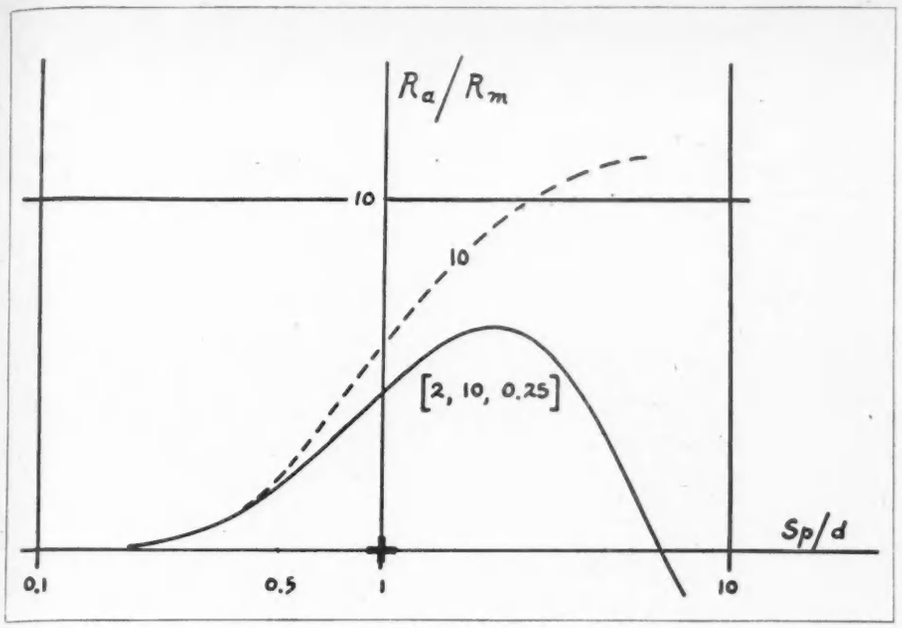
In view of the practical importance of determining the factors D, R_i and R as accurately as possible, it seems that some thought should be given to different approaches to the problem of electric log interpretation. Several possibilities exist. The principle of one of them, the partial-curve-matching method, is outlined below.

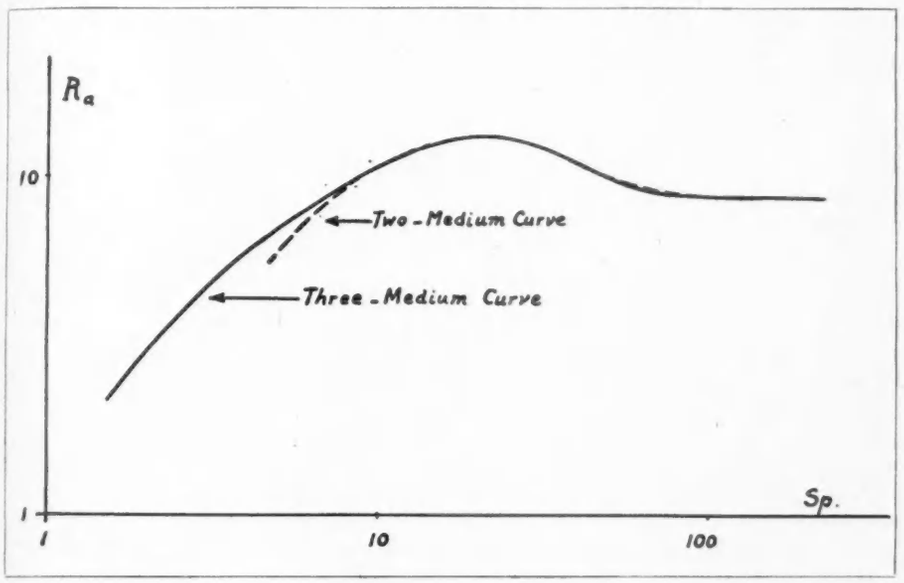
Partial-Matching to the Left

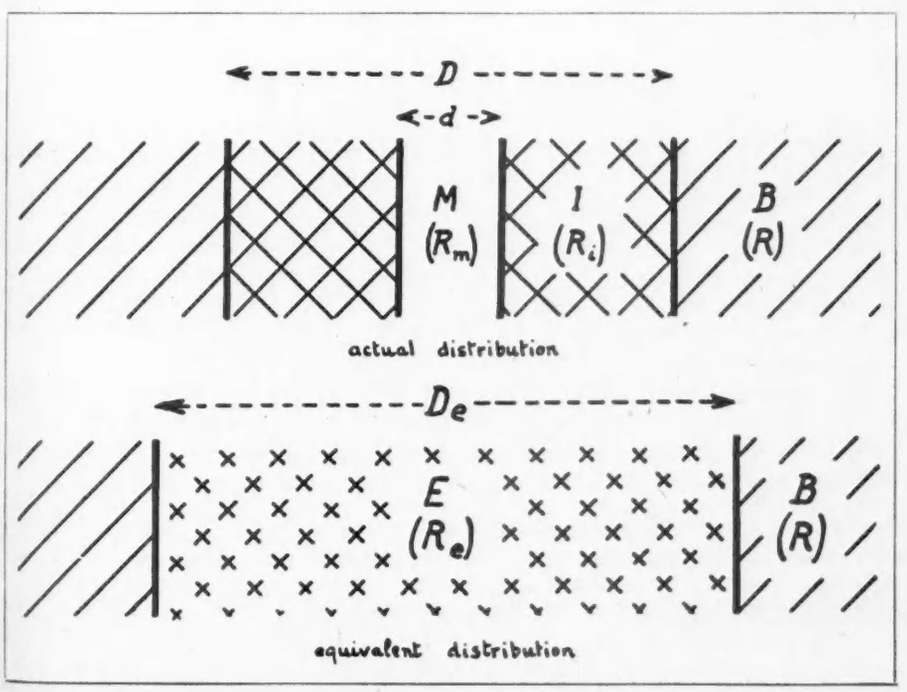
It has been shown that, in surface exploration, the extreme left portion of a three-medium departure curve is practically identical to the extreme left portion of the two-medium departure curve obtained by assuming that the thickness of the second medium is infinite. This simplification permits, in many instances, the use of two-medium curves to determine the characteristics of the upper formation of a three-medium distribution.

An analogous condition is found in resisitivity logging. In order to find out whether the partial-matching procedure is applicable practically to well logging problems, we will first investigate briefly the range where matching is satisfactory.

Referring to Figure 33, the plain line curve represents the three-medium departure curve [2, 10, 0.25] and the dash curve represents the two-medium departure curve [$R/R_m = 10$]. It is seen that







a satisfactory match is obtained when Sp/d is less than approximately 0.5, but that the two curves diverge rapidly for greater values.

A similar result would be obtained by considering any other three-medium departure curve, provided such curve is extended far enough to the left. It should be noted, however, that the range of satisfactory matching is wider when R is greater than R_i than when it is smaller than this latter quantity.

It can be shown that, in theory, this matching permits determining the mud resistivity in situ, R_m, and the hole diameter, d, with good accuracy by using the procedure previously outlined in this series. In practice, however, the method is usually not applicable at the present time for the following reasons. In the first place, good result is possible only if the corresponding experimental arc is accurately determined. This necessitates several resistivity measurements made with extremely small spacings: for example, several spacings only a few inches long. Such short spacings are not generally used at present.

Another reason which prohibits the application of the method is that, when extremely short spacings are used, representative resistivity measurements can be obtained only if the electrodes are very small spheres, or near-spheres. Otherwise, a correction should be made to take into account the size and shape of the electrodes.

Until such measurements and correction data are available it will not be possible to determine accurately R_m and d in mud-invaded formations by partial-curve-matching. In the meantime it will be necessary to use different methods to make these determinations. These methods are generally known; nevertheless, they will be mentioned briefly later for the sake of completeness.

In surface exploration, the foregoing

FIGURE 33 (Top) Principle of partial-curve-matching with very short electrode spacing data.

FIGURE 34 (Center) Example of partial-curve-matching to the right.

FIGURE 35 (Lower) Illustration of an actual resistivity distribution (top) and of its equivalent (bottom) when long electrode spacings are considered.

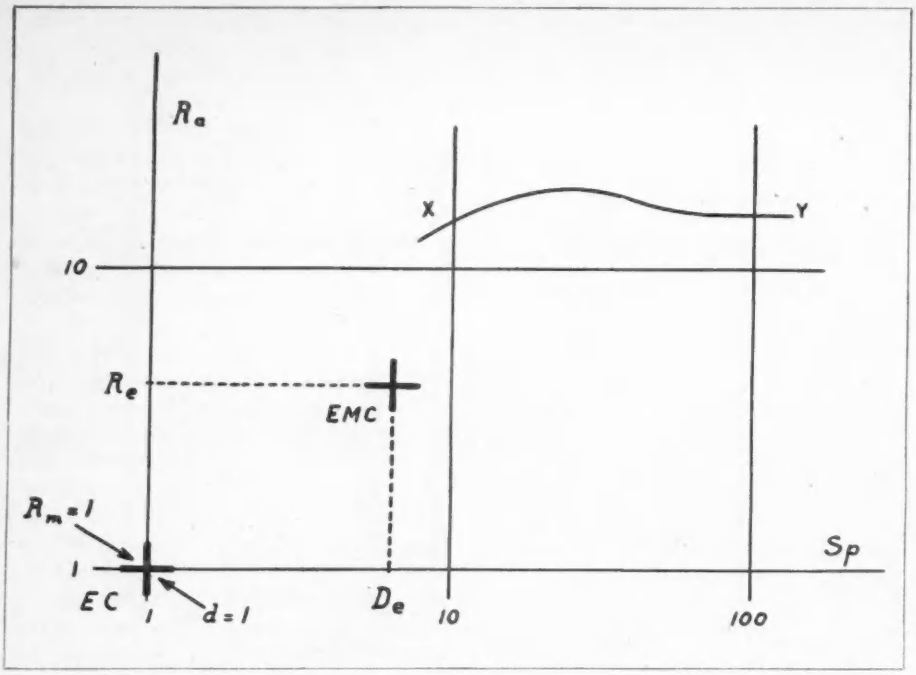


FIGURE 36. Principle of partial-curve-matching with long electrode spacing data.

limitations are not found in most instances because the thickness of the upper medium is much greater than the smallest electrode spacing used and greater than the electrode dimensions. Therefore, the influence of the electrodes may be neglected within the range of satisfactory matching, and accurate data on the upper medium can be secured.

Inasmuch as the purpose of this article is to outline the principles of a promising method of interpretation and not to supply at this early stage all the necessary interpretation data, it will be assumed below that the mud resistivity in situ, R_m, and the hole diameter, d, are accurately known, regardless of the method which may be used to make the determinations.

Partial-Matching to the Right

It can be easily verified that, for certain resistivity distributions, at least the extreme right portion of a given three-medium departure curve is practically identical to the extreme right portion of a two-medium departure curve. An example is shown on Figure 34. The three-medium curve is shown in solid line, and the two-medium curve in dash line. The foregoing condition indicates that the equivalent medium concept outlined in the preceding article for the case of surface exploration can be applied in certain cases in electrical logging also. This means that when long electrode spacings are considered, the conventional three-medium distribution of a mud-invaded bed B can be replaced by a two-medium distribution, as shown by Figure 35. For these two distributions the resistivity R of the outer medium B is the same.

Let R_e and D_e be the resistivity and diameter of the medium E which is equivalent to the mud column M and mud-invaded zone I.

Suppose that the extreme right portion of an experimental departure curve is the arc XY shown on Figure 36. For the sake of simplicity it will be first assumed that the mud resistivity is equal to 1 and that the hole diameter is also equal to 1. Arc XY is plotted on a transparent logarithmic grid with Sp as abscissas and R_a as ordinates. The point marked EC (experimental cross) on this plot is the point of coordinates:

$$d = 1, \quad R_m = 1$$

Now consider arc XY as being part of the two-medium departure curve corresponding to the following two media:

inner medium E: diameter D_e,
resistivity R_e;
outer medium B: diameter ∞,
resistivity R,

and we will determine the characteristics of the inner medium by using the conventional superposition method for two media. To do so, the transparent plot is placed over the conventional two-medium departure chart drawn on a similar grid and it is moved parallel to the coordinate axes until the experimental arc XY matches the right portion of a two-medium departure curve. When the best match is obtained, the theoretical cross of the two-medium departure chart, namely, the point of coordinates $Sp/d = 1$ and $R_a/R_m = 1$, is marked as a cross EMC (equivalent medium cross) on the transparent plot. It is obvious from the preceding process and from some discussions offered in the preceding article that the present EMC cross plays the same role which the theoretical cross TC of a calculated two-medium departure chart plays when an experimental two-medium curve is interpreted. Hence, the coordinates of the EMC cross are equal to the diameter D_e and to the resistivity R_e of the medium E, respectively. We have therefore determined experimentally the characteristics of the equivalent medium E.

If the mud resistivity, R_m, and the hole diameter, d, are not equal to unity, the following procedure (which is basically identical to the preceding one) is used.

Arc XY is plotted on a transparent grid (Figure 37) as a function of Sp and R_a. The point of the grid whose coordinates are 1 and 1 is marked as a cross EC (experimental cross). The point of coordinates d and R_m is marked as a cross TC (theoretical cross). Finally, cross EMC is marked by using the matching procedure described above.

It will be remembered that the coordinates read on the axes passing through cross TC are respectively Sp/d and R_a/R_m (see Part 4, May WORLD OIL). Therefore, the coordinates of cross EMC read on the TC axes are respectively D_e/d and R_e/R_m, from which D_e and R_e are readily obtained.

In practice we are interested in determining D and R_I, and not D_e and R_e. This can be attempted by seeking two analytical relations linking the four quantities involved, and solving for D and R_I.

A set of equations can be easily established by postulating a medium analogous to Hummel's fictitious medium. A different set can be obtained by considering a medium analogous to Maillet's. Still other equations can be obtained by considering other media. However, all these attempts have failed to give real satisfactory results: the data obtained do not match well precalculated curves and therefore are not representative. This is not too surprising since it is known that these fictious medium concepts are only approximations.

Empirical Method Probably Successful

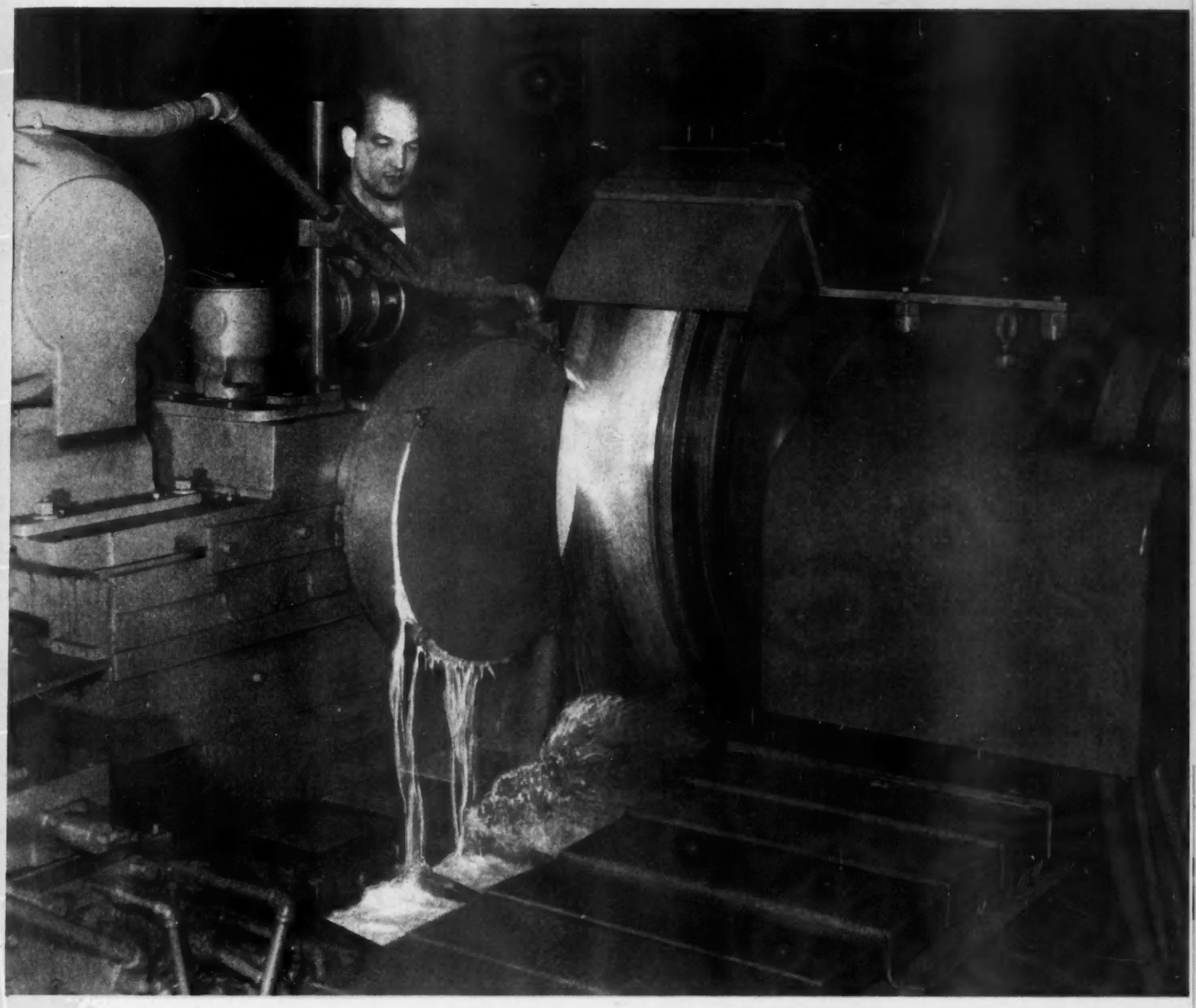
A more logical, and probably successful, solution of the problem is to reverse the process and to use precalculated curves to establish empirically the desired relations. This was done for the following resistivity distribution:

$$R > R_I > R_m$$

and the results are tentatively reproduced on Figure 38. This chart represents the factors R_e/R_m and D_e/d as a function of R_I/R_m and D/d. The data are probably inaccurate because we do not have at present enough three-medium curves calculated with the accuracy which is necessary to establish a reliable chart. In the areas of the plot where no satisfactory data were at hand, the chart was completed with the help of

Drilling Rigs..

New "Cardwell" brake flanges will save at least $5,000 in maintenance costs and down-time during the life of the rig.



Brake flanges that are too hard to wear out are now standard equipment on all "Cardwell" rigs. All new rigs are equipped with 550-600 Brinnell (54-58 Rockwell C) brake flanges. All service flanges ordered for old "Cardwell" rigs in the field will be the new flanges at no increase in price.

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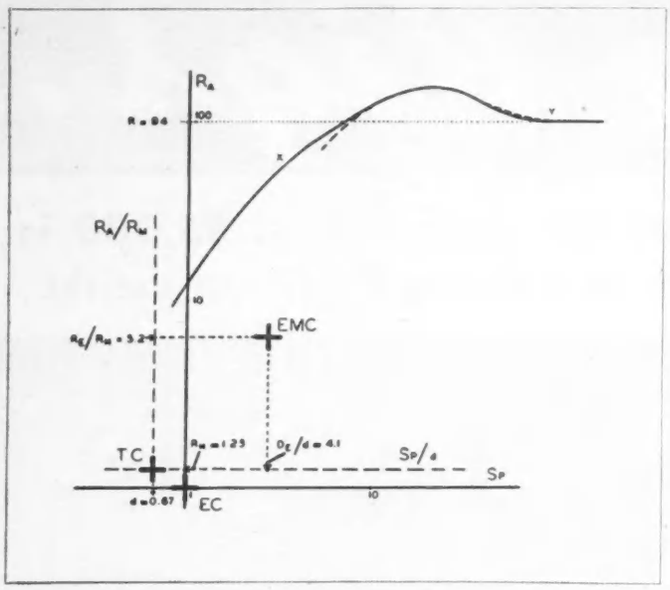

FIGURE 37. Interpretation of extreme right portion of experimental departure curve.

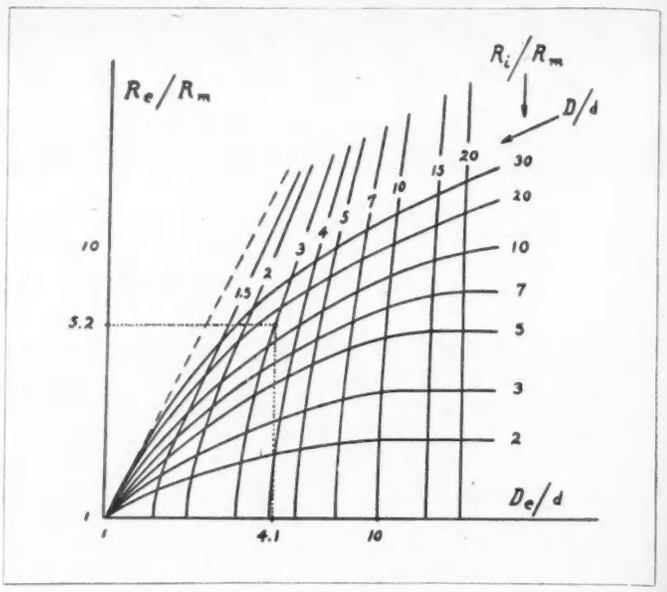

FIGURE 38. Equivalent medium chart when bed resistivity is greater than resistivity of mud-invaded zone (tentative).

a similar chart calculated for the case of Maillet's fictitious medium. This latter chart will be presented later.

The inaccuracies resulting from the unsatisfactory procedure used in plotting the data do not change the principle of the interpretation method outlined below because it is felt that the main features of the plot are basically correct. Hereafter, this plot will be called "Equivalent Medium Chart."

Use of Equivalent Medium Chart

Suppose that the partial-matching of a given arc XY gives the following data:

$$D_e/d = 4.1$$
$$R_e/R_m = 5.2$$

The point having the foregoing coordinates is marked on the equivalent medium chart (see Figure 38). It is seen that this point falls on the R_i/R_m and D/d curves having the following values:

$$D/d = 3$$
$$R_i/R_m = 14$$

Since $R_m = 1.25$ and $d = 0.67$ (see Figure 37), we have

$$R_i = 17.5 \text{ ohm-m.}$$
$$D = 2 \text{ feet.}$$

The numerical value found above for D/d falls within the equivalent range (see Part 4 of this series). Therefore the foregoing procedure should have given the equivalent number U, and not the ratio D/d. This anomalous result is probably due to the fact that the chart of Figure 38 is inaccurate.

In the foregoing discussion it has been assumed that the electrodes are of very small dimensions so that the conventional two-medium departure charts can be used without correction. Also, the type of electrode arrangement used has not been specified. In fact, it is probable that an equivalent medium chart established for two-electrode arrangements can be used also for three-electrode arrangements and vice versa. Finally, the bed concerned was supposed to be very thick so that the conventional departure charts could be used.

Determination of Bed Resistivity

The last step of our interpretation problem is to determine R, resistivity of the bed under investigation. This is done as follows.

If the extreme right portion of the experimental departure curve reaches an asymptotic value, the bed resistivity is equal to this asymptotic value (Figure 37).

If the experimental departure curve is not extended sufficiently far to reach the asymptotic value, the bed resistivity cannot be determined by inspection, but it can be accurately estimated if the characteristic hump Z of arc XY is well defined (Figure 39). In this case it is seen that the partial-matching procedure previously described can be applied with fair acuracy. While arc XY is superimposed on the adequate two-medium curve, the extreme right portion of this curve is traced on the transparent grid as an arc YW. The ordinate of extremity W of this arc, read on the experimental ordinate axis, gives directly the desired bed resistivity R.

The Partial-Curve-Matching Method of interpretation will be further discussed in a forthcoming article which will conclude the present series.

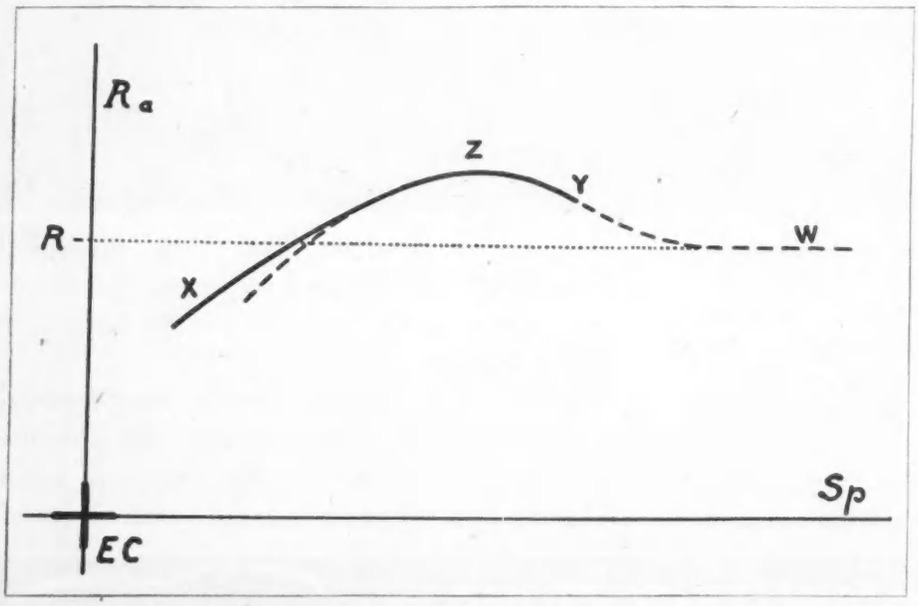

FIGURE 39. Determination of bed resistivity.

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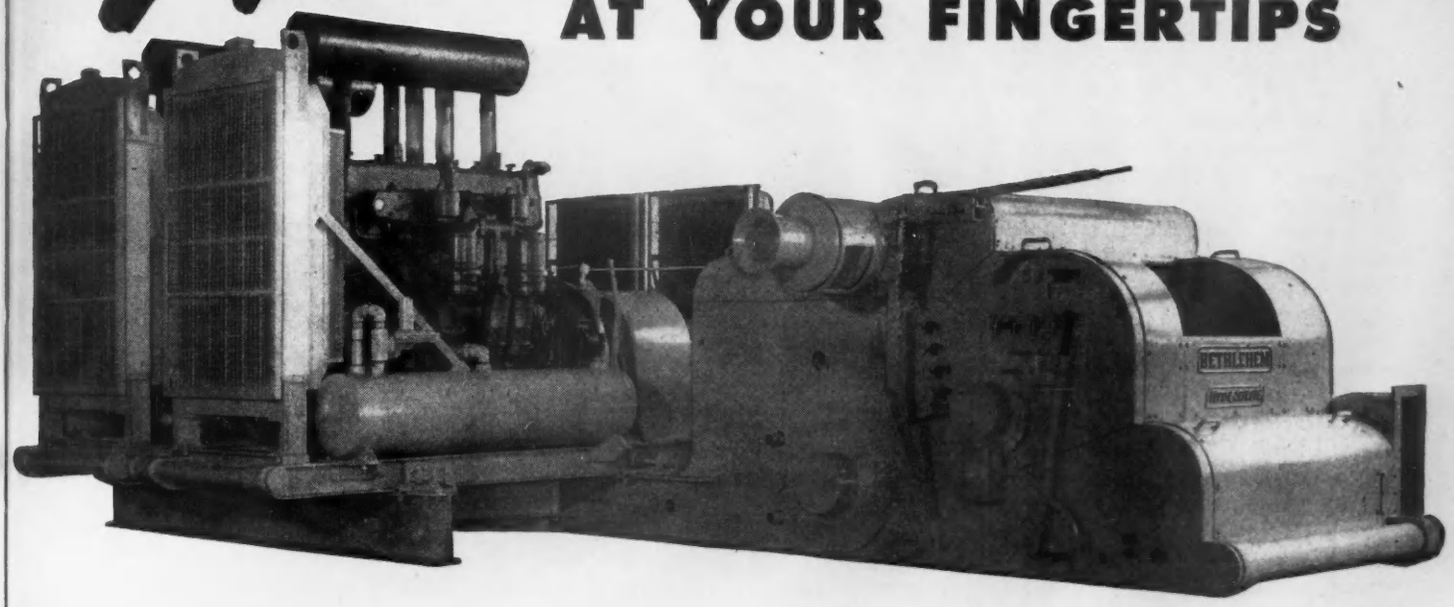

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Plugging Off Cavities in *University Field*

By FRED E. BRYSON

CEMENTING TECHNIQUE which has proved successful in plugging off lime cavities in the University field of East Baton Rouge Parish, Louisiana, is described. It may be useful in fields along the Texas and Louisiana Gulf Coasts where lost circulation in Lower Miocene lime sections cannot be mudded off.

ONE of the major hazards encountered in drilling in the University field in East Baton Rouge Parish, Louisiana, as well as in other areas along the Texas and Louisiana Gulf Coast, is that of successfully penetrating through and getting a good casing job below the vugular and cavernous sections of lime formations which must be penetrated in the lower Miocene zones. Before a successful method was evolved, operators and contractors approached this problem with considerable misgivings. Well they might, for in many instances lost circulation resulted in junked and abandoned holes, causing considerable financial losses.

The problem of plugging off cavities which are characteristic of the University field and similar areas apparently has been overcome and by following the technique which is here described drillers have been able to drill through the hazardous zones and successfully set pipe and complete wells.

Deep production in the University Field is from the lower Miocene encountered at depths from 9200 to 10,000 feet. The cavernous conditions exist in the upper portion of the Heterostegina, or "Het" lime zone. The depth of that zone is from 7570 to 7700 feet, depending upon the position of the well on the structure.

Within this interval, it is believed that the porosity and permeability of the lime are due to relatively large primary and secondary channels charged with very saline water, as illustrated by Figure 1. The pressure within this zone is equal to the normal pressure gradient of 0.465 pounds per square inch per foot times the depth encountered.

Upon drilling into this zone, returns are suddenly lost and the fluid level in the well drops to 400 to 600 feet below the surface. If circulation cannot again be established by pumping in extra quantities of bentonitic mud, other steps must be taken.

Prior to the development of a suitable method to drill through the cavities, operators also were faced with the hazard of freezing the pipe when circulation was lost and therefore were forced to pull out of the hole as fast as possible. Consequently, experience has proven that a protective string of casing must be set above the cavities in order to protect the hole when this occurs.

The general casing pattern in this field is as follows:

Type	Size	Landing Depth Feet
Conductor	20-inch	90- 100
Surface	13⅜-inch	1350-1400
Protective	9⅝-inch	7400-Top of cavity
Production	7-inch	Short string, packed off to 9⅝-inch casing

The landing depth of the 9⅝-inch protective string is determined by comparing the drilling time record with the electric log of an offset well. The landing depth is directly above the 40-foot shale section overlying the cavity, as illustrated in Figure 2.

The first well that was successfully drilled through the cavity was cased as described above; however, the plugging off of the formation proved expensive. Several commercial admixtures and roughage material such as cotton seed hulls, planer shavings, Spanish moss, and 500 cloth cement sacks were pumped in along with practically a 100 percent bentonite mud in order to wall up the formation, but results were negative.

When the above measures failed operators evolved a cementing technique which has proved successful.

When returns are completely lost, the mud weight is reduced from ten to 9.5 pounds per gallon, and from 50 to 40 seconds viscosity. A high rate of circulation is maintained and an attempt is made to drill through the entire cavity section, which is approximately 130 feet thick as illustrated by the electric log in Figure 2. The drill pipe is then pulled and a retrievable cement retainer is run in on the end of the drill pipe and set just above the shoe of the 9⅝-inch protective casing. This retainer is necessary because, as previously pointed out, the fluid column is standing in the hole between 400 and 600 feet below the surface. Therefore the retainer, by supporting the column of drilling fluid, prevents the squeezing of the cement back into the formation.

The purpose of the cement is to wall up, or plug up, the relatively large primary and secondary limestone channels that constitute the cavity. Usually 150 sacks of 15.5 pounds per gallon standard Portland cement is pumped into and displaced from the drill pipe through the retainer by the usual squeeze cementing procedures, except that no squeeze pressure is required to break down the formation or to place the cement.

The retainer is retrieved 24 hours after placement of the cement and an attempt is made to fill up the hole with mud. If the hole takes mud, i.e., does not fill up, then another batch of cement, using 2 percent calcium chloride as an

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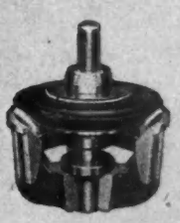

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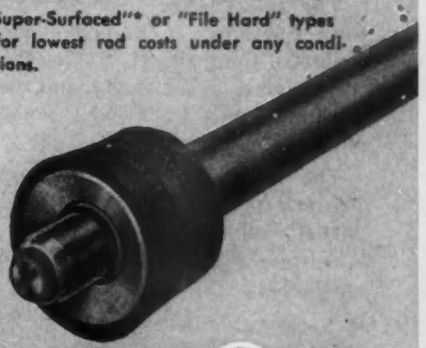

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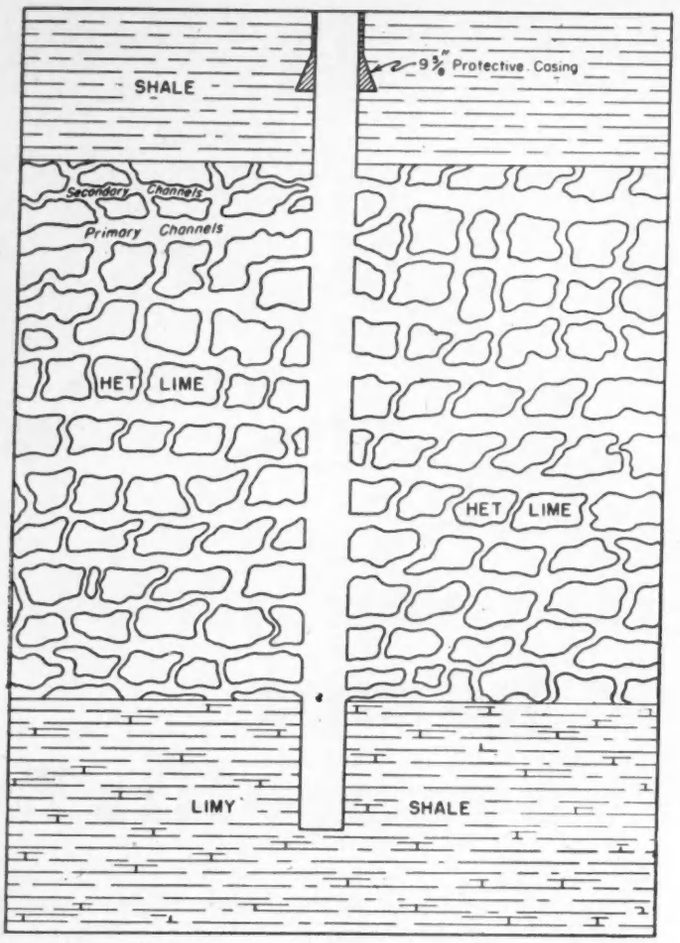

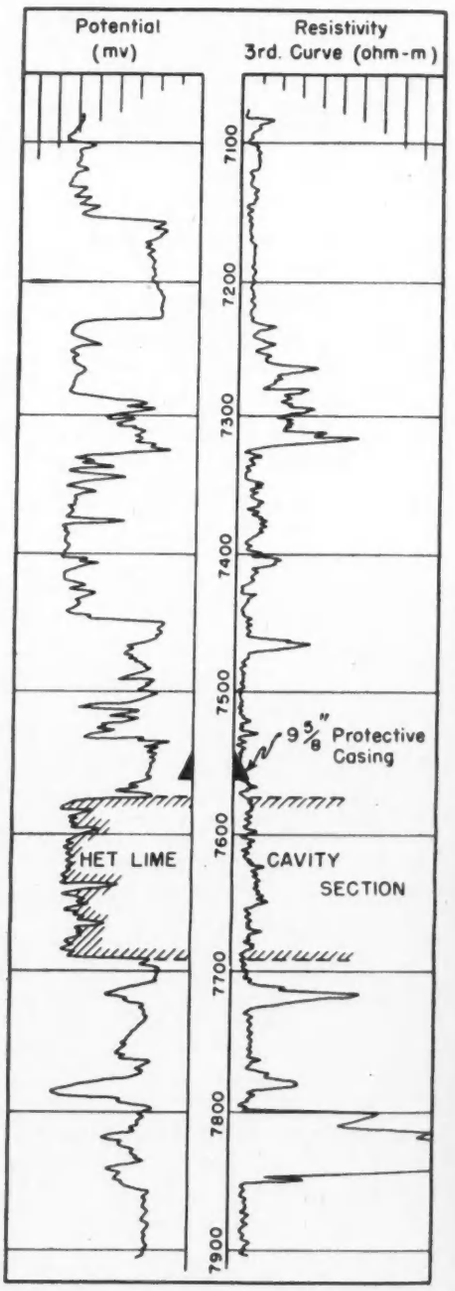

FIGURE 1. (top left). Primary and secondary channels in the Heterostegina lime section.

FIGURE 2 (lower right). Typical electric log of the cavity section.

FIGURE 3 (top right). Drilling progress curves of three wells in University field, East Baton Rouge Parish, La. (1) Wm. Helis No. 14 H. B. Nelson; (2) Wm. Helis No. 1-A Dearing Community; (3) T. G. Markley No. 2-A Knox-Amiss, et al.

accelerator, is pumped in. This procedure is repeated as often as eight times, or until the hole fills up with mud. A rock bit is then run in to drill out the cement plug.

The major expense incurred is rig time. As shown in Figure 3,[1] the Wm. Helis Oil Company H. B. Nelson No. 14 lost six days in the cavity, and the T. G. Markley Knox-Amiss and Faunbacher No. 2-A lost ten days.

The expense of setting the customary 9⅝-inch protective string of casing is partially offset by completing the wells, which come in from 9200 to 9600 feet, with a short production string of seven-inch casing, which is packed off in the 9⅝-inch casing with a screw through type packer. Thus the 9⅝-inch casing serves both as a protective string and as a producing string, which greatly reduces the casing costs.

Emphasis has been placed on the use of cements in plugging off these cavernous sections, but experiments with plastic-cement combinations should prove satisfactory, because of their short setting time. Roughage material used along with highly bentonitic muds is not successful in plugging off cavities in the University Field. In wells where there is only a partial loss of returns, the entire section is drilled, and the cavity cemented through open ended drill pipe.

The general program is to drill completely through the section, using a high velocity, low viscosity drilling fluid, which will result in a minimum amount of friction or pressure drop in the annular space. Under the most severe conditions the entire lime cavity section is drilled with water with partial or no returns, and then the section is plugged with cement.

ACKNOWLEDGEMENTS

The writer wishes to acknowledge the assistance given by G. A. Dorgan, Wm. Helis Oil Company, and Jay Love, Danciger Oil & Refining Company, in the preparation of this article.

REFERENCE

[1] G. F. Shepherd, Geologic Uses and Economic Advantages of Drilling Time Recording. Drilling, February, 1947.

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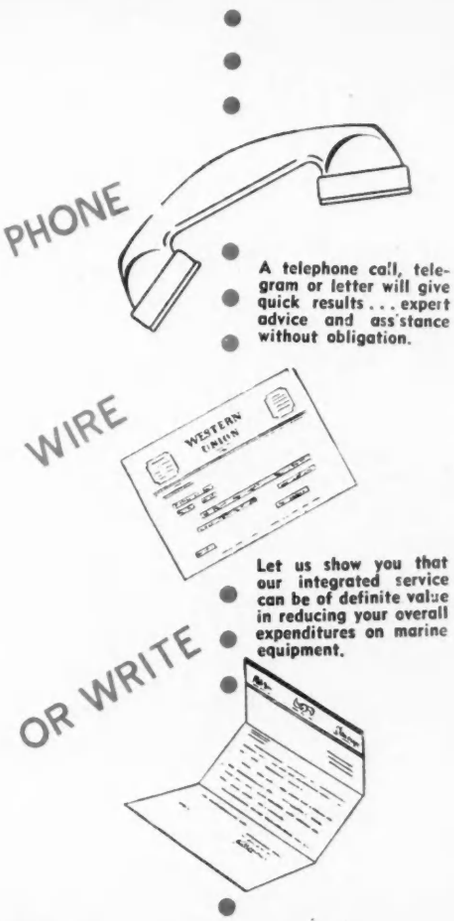
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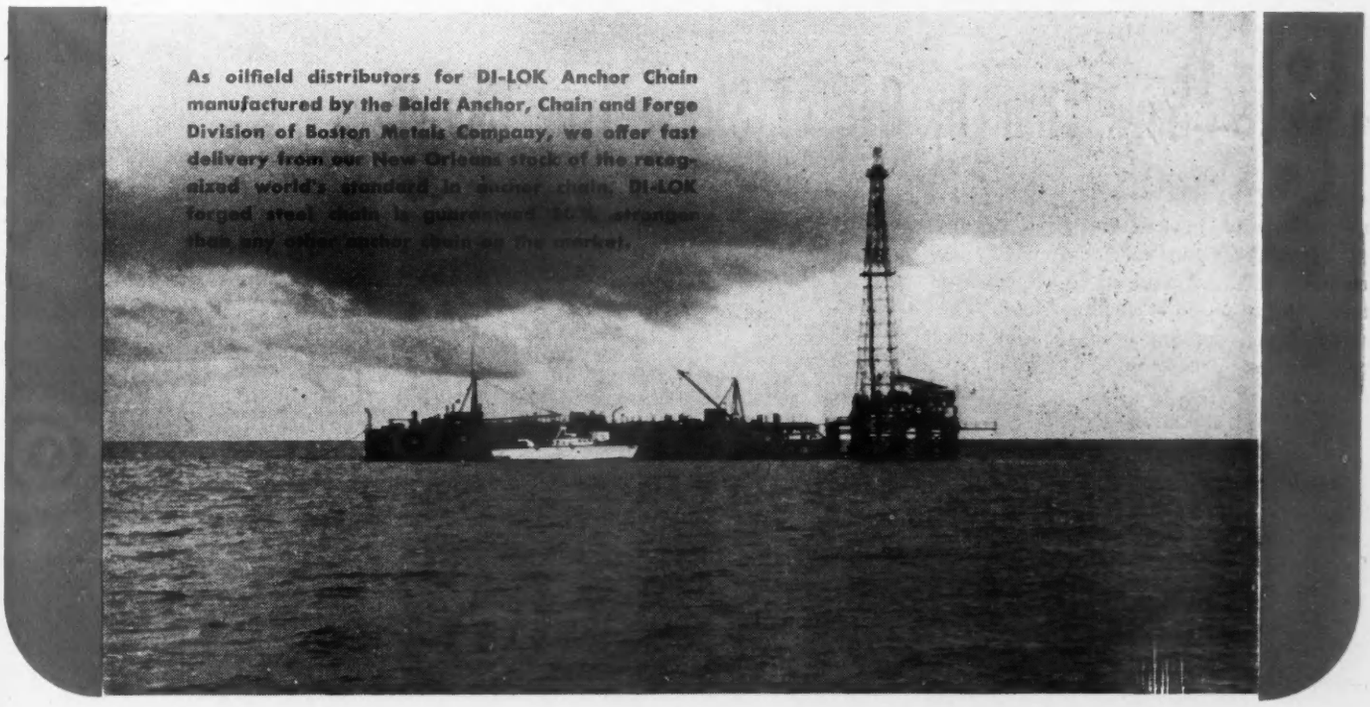
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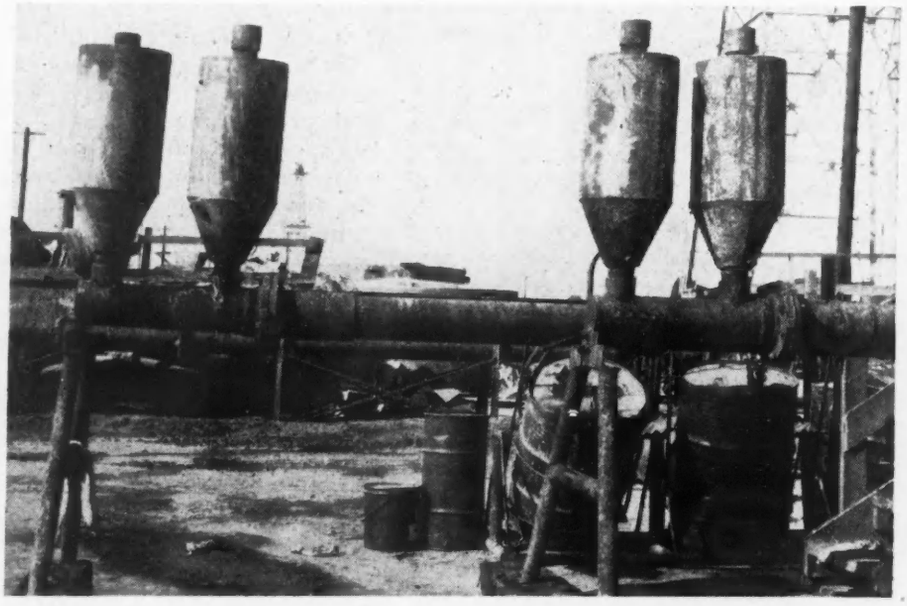
HOW TO—Effectively Silence Exhaust Noise of Engines

On drilling well engines where the sound of the exhaust is objectionable, mufflers of one type or another are generally installed. Many such exhaust silencers are large and cumbersome to move, tear down and transport, and frequently require costly supports when in use at the well. One type recently devised by a tool-pusher consists of a pair made of 12-inch, light weight pipe. The cylindrical pipe sections are only 18 inches long resting on 10-inch inverted cones tapering from the size of the pipe body to 3 inches where a short nipple is welded. Top of the body is closed with a flat head containing a 3-inch nipple with a collar attached so that a bull headed tee can be installed if desired.



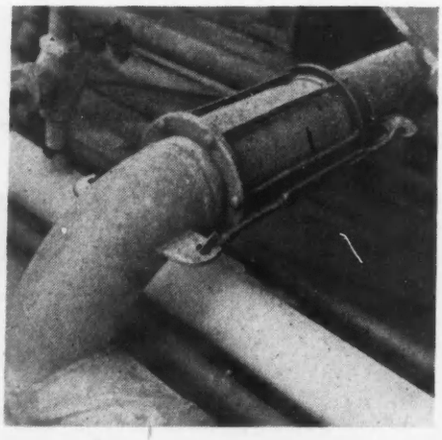
The installation of each pair of mufflers is made on a short section of 4-inch pipe having a companion flange so that connections can be made to the exhaust pipe and extended as far as desired from the rig. The flat head on the closed end of the muffler section carries a bracket to be bolted to an "A" frame support which may or may not be set on timber cribbing, depending upon the terrain and the height of the rig structure from the ground level.

When a two-engine job is employed, there is a requirement of two twin mufflers with the exhaust pipes laid closely together, but with an extension permitting spacing of the pairs of mufflers. Quench water is introduced into the exhaust pipes at the engines so that the exhaust is flooded with steam when the drilling mud carries gas.

HOW TO—Save Time by Use of Sleeve-Type Couplings

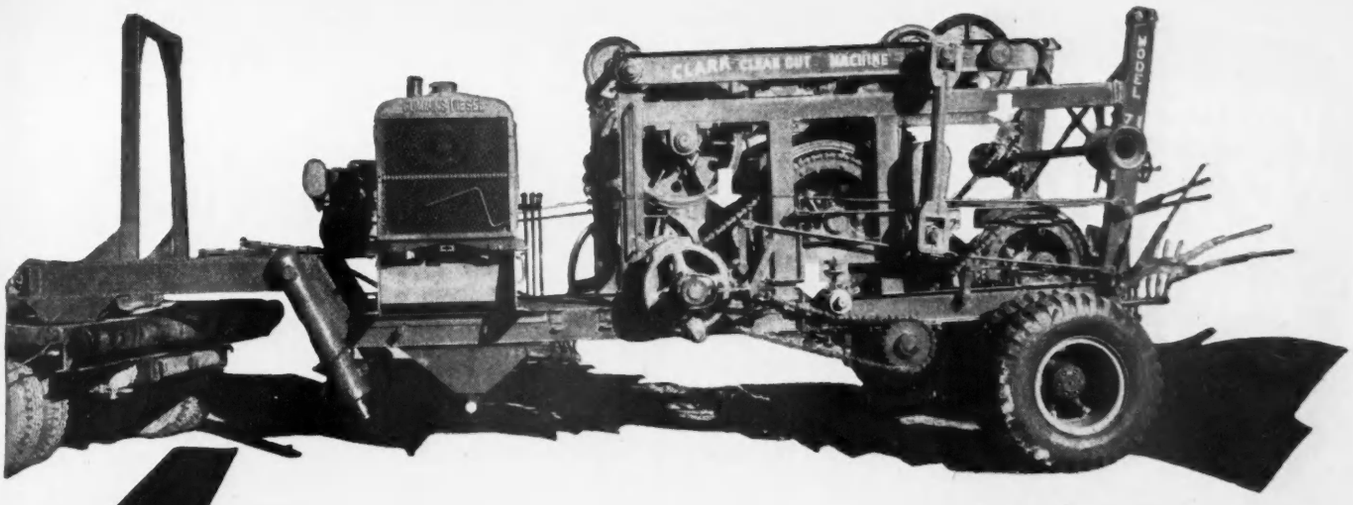
Pipe fittings that are easily and quickly made and broken on all types of service have been used extensively to reduce the time required to set up and tear down modern drilling rigs. The sleeve-type coupling used to join relatively large diameter pipe has found application for this purpose, particularly on mud and steam lines.

Illustrated is a six-inch sleeve-type coupling installed on the steam line furnishing steam to a 14x14 steam engine. Insurance against breaking the joint through the constant throbbing of the line due to the vibration of the engine itself and the surge of steam pressure within the line has been made possible by two turnbuckles. Four tabs



or "ears" were welded to the joining sections of steam lines as shown. They extend about two inches from the pipe and are drilled with a three-quarter-inch hole. Hooks on either end of the turnbuckle fit into the holes.

Screwing up on the threads of the turnbuckle draws the two joints of pipe tightly together and holds them in position. Bolts on the coupling are tightened to form a pressure-tight seal around the two joining sections of pipe, but constant vibration is likely to break this pressure seal unless it is reinforced. The unit is capable of withstanding pressures in excess of 300 pounds per square inch, and has proven quite satisfactory. Little effort is required to break the joint, and its light weight facilitates handling.



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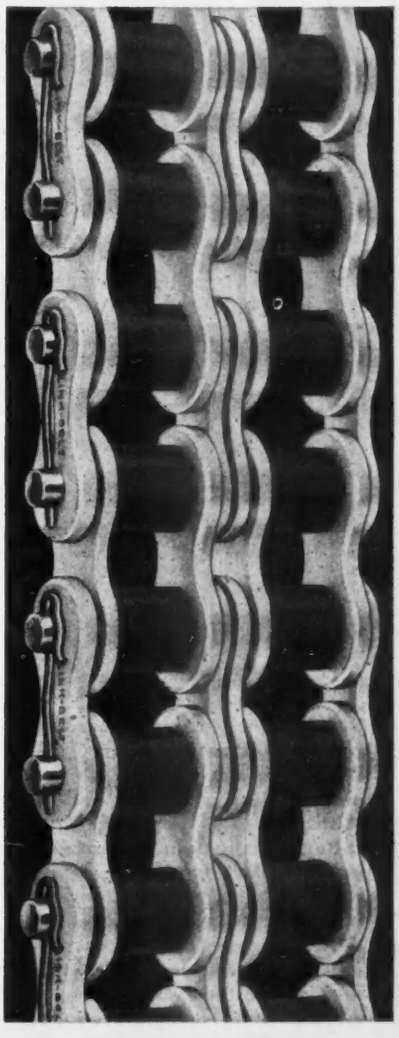

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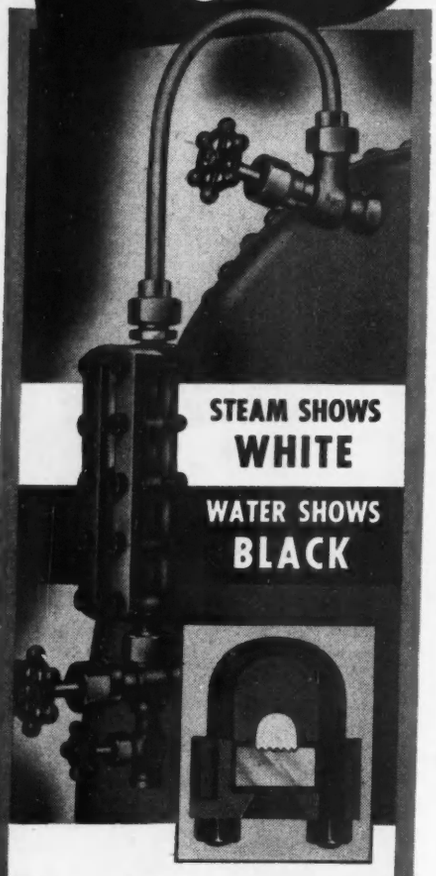

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HOW TO—Shield Poppet Valves with Disks

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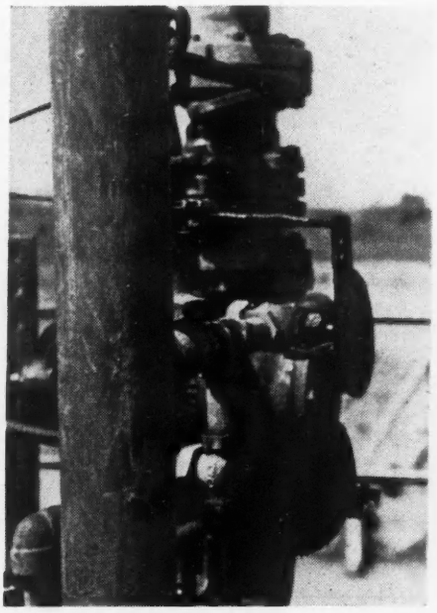
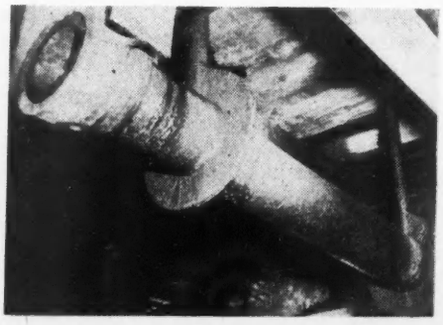


HOW TO—Anchor Drawworks for Easy Removal

It is an absolute necessity that the drawworks be firmly anchored to the derrick substructure of a drilling rig, and there are many ideas as how to accomplish this. The method illustrated is one that has proven successful in providing a sturdy anchor for the drawworks, while at the same time affording a means for quick removal of the drawworks from the derrick floor for rig moves. With this tiedown, it is not necessary to unscrew a dozen largs bolts. Only two bolts need be removed and the cross bar loosened.

The anchor consists of a heavy crossbar mounted at either end in heavy bearings that have been welded to the main cross beams of the substructure beneath the drawworks. Two heavy tie bars of 1¾-inch steel extend through the derrick floor and into the main cross beam of the drawworks frame. Large hex nuts hold the tie bars to the drawworks and afford a means of tightening the bars once the unit is positioned. To the opposite end of the tie bars was welded a disc cut from one-inch plate steel of a diameter to accommodate the four-inch cross bar. The complete unit is extremely sturdy and capable of withstanding hundreds of tons pull.



To dismantle the anchoring device, it is only necessary to loosen the tiedown rods and knock the cross bar through the bearings. The device is as easy to rig up, requiring that only two heavy nuts be screwed into the drawworks frame, as compared with aligning half a dozen or more as in other methods.

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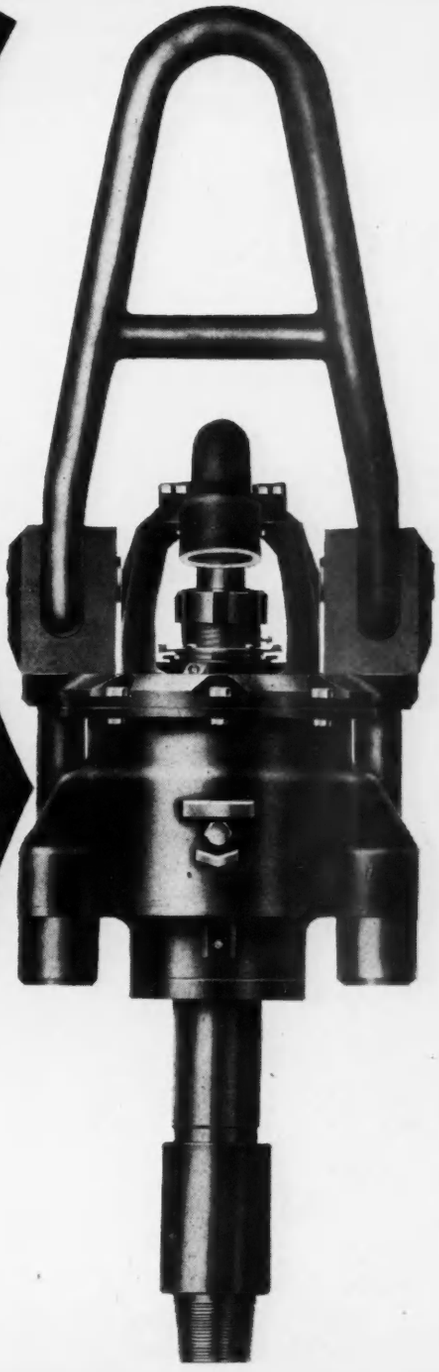

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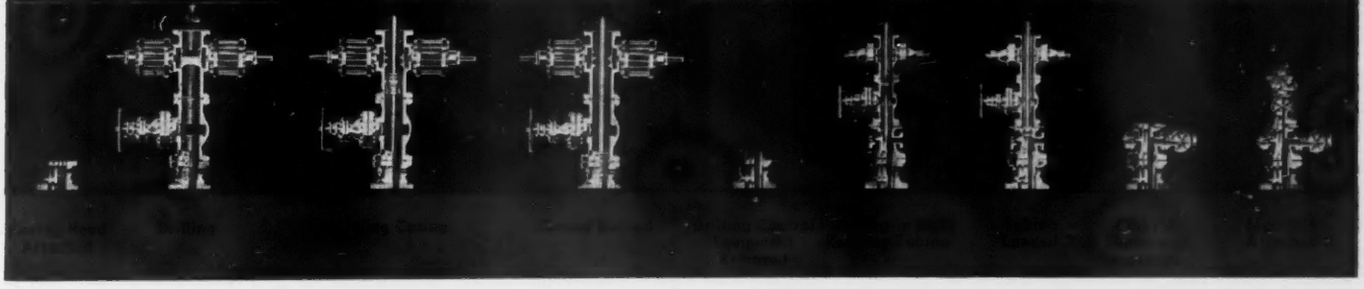

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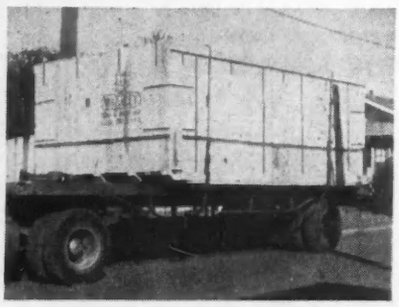

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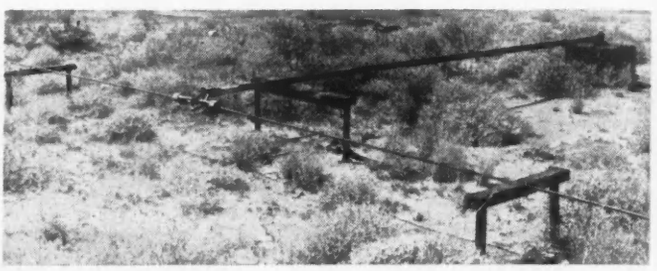
HOW TO—Speed Up Low-Angle Rod Line Turns



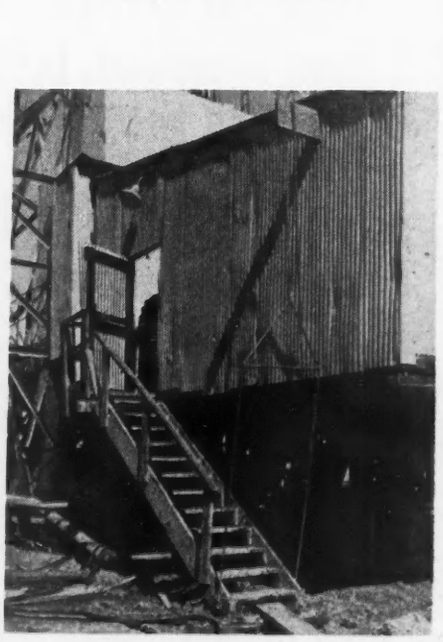
Frequently it is necessary, in a rod line hook-up, to guide the line through a very low angle turn in order to have the power and well jack in proper alignment. Since a hold-over or stiff-leg of conventional size would tend to shorten the effective stroke at the well, it is desirable to provide one which has as great a length as possible; the longer the arm, the closer will be the arc of travel to a straight line at the point where the arm contacts the rod line.

One company in the West Texas area finds it desirable to use a 20-foot length of tubing at such turns, the long arm being installed as shown. At the anchor post end, a pipe tee is screwed to the pipe, this fitting then being placed over the steel post set in a block of concrete. Mounted 18 inches to two feet above the ground, the hold-over at the line end moves through its arc of travel upon a two-legged support capped with a piece of wood, the latter smeared at intervals with heavy grease. The pivot bearing also is lubricated from time to time. The unit is easy to install and provides a type of motion that is desirable on the low-angle turns.

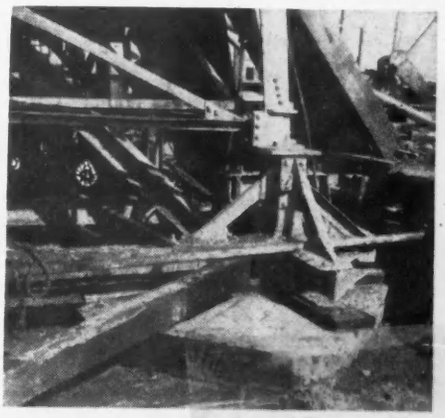
HOW TO—Speed Rigging of Ladders and Stairways

The rigging-up of ladders and stairways on a drilling rig having an elevated floor ordinarily is one of the time-consuming jobs necessary each time the rig is skidded to a new location. One drilling contractor eliminates much of this work by permanently attaching the stairways to the rig structure.

Each unit is hinged to the upper landing and may be raised with the aid of a bail which is attached at or near the bottom step. The bail, made of sucker rod material, is welded to plates which in turn are bolted to the side of the stairway. A rope attached to the upper end of the bail is thrown over a projecting section of ceiling joist of the engine house. When set up for use, the stairway rests on the ground, but when the rig is to be moved, the unit is raised five or six feet off the ground merely by taking up on the bail rope. By this method, the several hours work formerly required to install stairways is reduced to less than 15 minutes time.



HOW TO—Build Portable Pads for Derrick Base



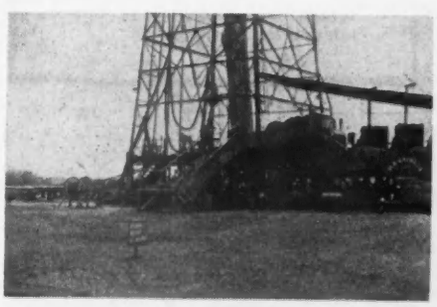
In an area where moves are frequent and over comparatively short distances, one drilling contractor saves considerable rigging-up and tearing down time by employing small portable wooden pads. Placed directly upon the concrete mat, these pads are easily maneuvered and are readily blocked up if necessary.

Each pad consists of six heavy timbers of approximately 12x12 size laid side by side and drawn up with long bolts run through laterally. Corners are sawed off to simplify handling positioning. Each of the derrick legs is provided with extended feet to provide greater friction and supporting area atop the wooden pads. As soon as the rig is shifted or lifted off the pads, the units are easily picked up with winch trucks and carried over for placement on the next location, eliminating much time-consuming handling of individual planks and blocks.

HOW TO—Reduce Splashing in Mixing Tanks

In order to reduce, or at least confine, excessive splashing of mud when chemicals or additives are being mixed, one operator brings the mud or fresh water line in at one corner of the mixing tank, and covers the area with a piece of flat steel plate as shown. The plate, measuring about two feet square, is welded to the sides of the tank, and provides a small platform on which the man can stand as he dumps the dry chemicals in the tank. By cutting an elongated opening in the plate, the pipe elbow may be set in loosely, permitting complete removal of the line when moving; or the elbow and fitting can be permanently welded in, allowing the use of a union to connect the line to the unit.

HOW TO—Maintain Truck Turning Area



Considerable time is frequently lost on a drilling rig, by company trucks and those of service companies through their ability to maneuver properly in the immediate vicinity of the rig due to presence of parked cars belonging to employees and visitors. To help eliminate much of this difficulty, one large company operating in a West Texas field has adopted the practice of keeping one side of the location cleared of vehicles. A small sign placed beside the road informs the visitor of this policy. The yard is maintained in a neat condition and is large enough to permit a truck and trailer to unload at the rack, then pull out without backing and maneuvering.

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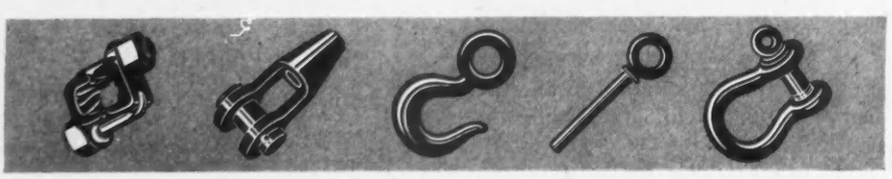


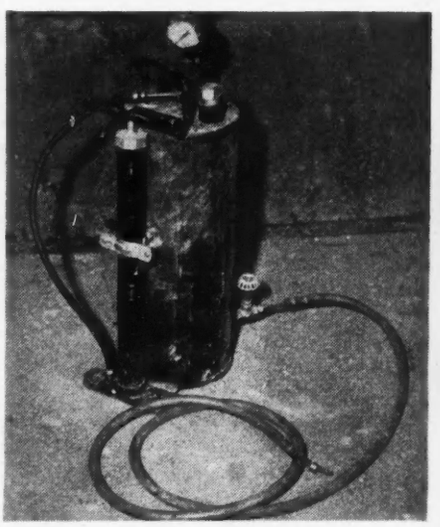
DRILLING HINTS

HOW TO—

Make A Solvent Sprayer

Oily machinery around the drilling rig can be easily cleaned with the aid of a handy solvent spraying device, made from available parts and salvaged pipe.

The pressure chamber was made from a two-foot section of ten-inch casing that had been welded closed at both top and bottom. A common automobile pump was bolted to a plate at the bottom of the unit, and held solidly to the cylinder by means of a conduit clamp. Pump



pressure exhausted into the top of the vessel where a connection had been welded. Pressure in the vessel was indicated by a gauge connected to a collar which was welded to the top of the closed end. A two-inch collar and plug provided a means for filling the tank with the solvent fluid.

Outlet for the solvent under pressure may be seen near the bottom of the cylinder on the right where a valve is connected into the vessel. A short piece of copper tubing screwed into the valve accepts a long section of rubber air hose. The outlet end of the hose is also fitted with a similar piece of copper tubing, to the end of which is attached the spray nozzle.

After the solvent has been poured in to fill about 2/3 of the cylinder, the pressure can be pumped up to 40 or 50 pounds per square inch, and the complete unit carried to any point about the rig where the pressurized solvent may be required. The fine spray of solvent under pressure quickly and effectively removes oil, grease and dirt.

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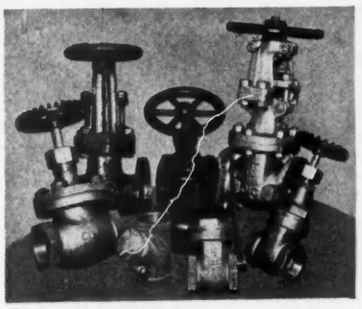

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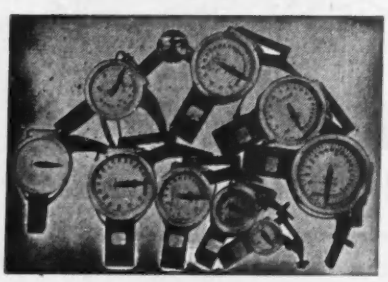

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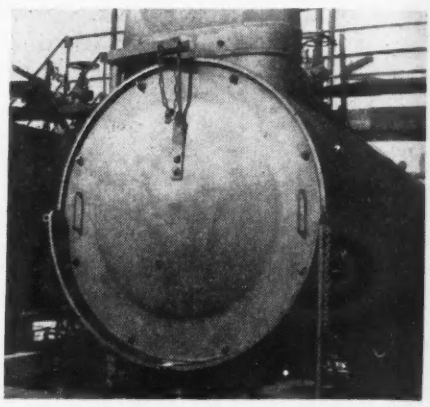
HOW TO—Safely Remove Boiler Smoke Door

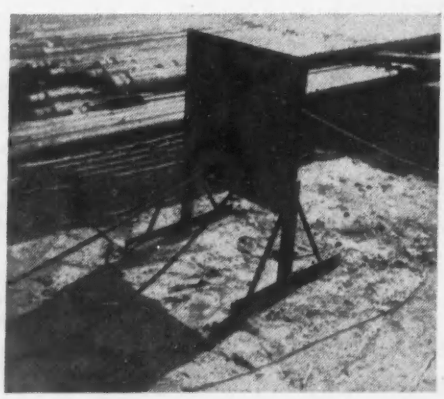


An innovation on boilers provides for a smoke door swing to support the door when it is removed during cleanout and inspection work. This device is hinged at the boiler shell and extends to the center line of the boiler. The swing arm, a piece of channel iron, is fitted with an eye bolt so that adjustments can be made when the door is positioned for reassembly.

This adjustment is made by screwing up or letting out the nut on the eye bolt. Inasmuch as it is possible that the nut could become completely unscrewed when the smoke door is removed and supported entirely by the swing support, a safety measure was added to prevent this occurrence. A section of chain, approximately 14 inches in length was welded to the smoke door and to the supporting channel iron bracket. It is loose enough to allow considerable adjustment either up or down by means of the eye bolt. In case the nut does come completely unscrewed, the smoke door will not fall but a few inches, thus avoiding a possible accident and a strenuous lifting job.

HOW TO—
Reduce Fire Hazard

A small portable junction box and connector panel which is set up easily outside the rig floor area is of considerable value in areas where the possibility exists that escaping gas or volatile oil may be ignited accidentally by arcing of electrical fittings when connections are made or broken. A unit employed by one company is built of steel and has two widely spaced legs to eliminate the possibility of being knocked over. The rectangular panel has mounted on it three junction boxes and connector fittings, sufficient to serve the average re-



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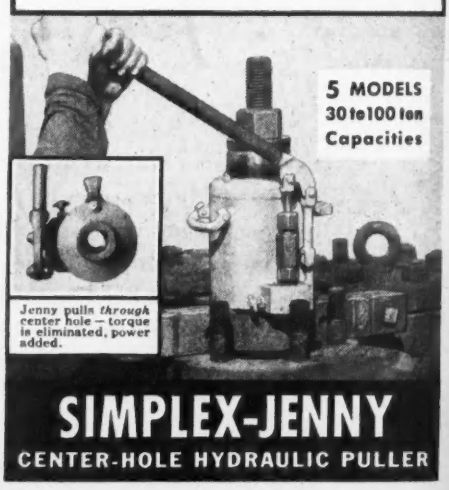

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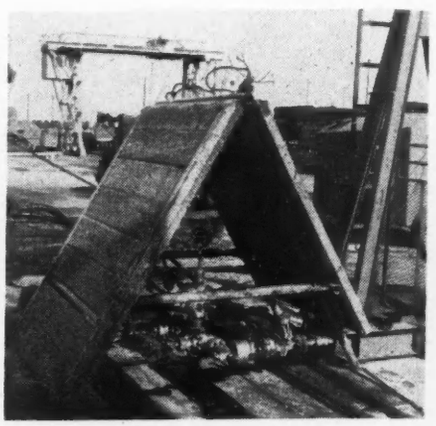
quirements of a pulling unit, lights, and miscellaneous needs.

Not only may this possible source of fire be placed some distance from the rig, but it permits a saving in electric cable ordinarily required on a job. A single cable, coming from the central box on the location, can serve the entire panel, and from there on, only shorter leads are needed to carry current to the scene of operations. Mounted on this panel, connector boxes are kept free of mud and oil, and are readily accessible.

HOW TO—Protect Christmas Tree From Damage

When drilling a well in a congested town-lot area, danger always exists that the christmas tree or other easily damaged pressure equipment may be harmed by objects falling from the derrick. One company overcomes part of this danger by erecting over adjacent wells an A-frame shelter device which will withstand or at least ward off very heavy blows.

The framework is made of salvaged



lengths of heavy pipe decked over with heavy 3x12 planks, the latter edged with heavy angle iron. In the erected position, the two halves of the shelter are held apart by two horizontal stiff-legs which swing out from one section to latch onto the opposite section. Being hinged at the apex with telescoped sections of pipe, the shelter may be collapsed and carried flat for easy moving between jobs. Slings are attached at the apex to facilitate hoisting the assembled device up and subsequent lowering over the christmas tree.

HOW TO—

Cool Drilling Fluids

When drilling very deep wells, the drilling fluid absorbs the earth temperatures, and in many cases exceeds the normal temperature gradient of the earth. It is desirable to cool the mud if the temperature goes above about 200° F. This can be done in one of many different ways, but illustrated is a method used to aerate and cool the fluid, with little additional equipment.

The method consists of pumping the hot mud through parallel, horizontal

Fig. 179 Acme W.L. Knife Cutters.

Fig. 180 Cover Plate

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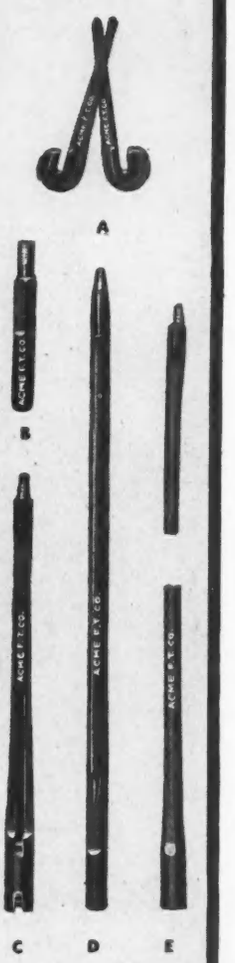

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C—Wire Line Knife
D—Long Stroke Jar
E—Sinker

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THE SIDES of a V-BELT

Diagram of V-Belt in Sheave-Groove

Are ALL that TOUCH the Pulley

The SIDES Do ALL the GRIPPING Naturally — They GET the WEAR!

The moment you look at a V-Belt in its sheave, you see that the *sides* are the only part that ever *touch* the pulley. The *sides* do all the *gripping*—they get *all the wear* against the sheave groove wall. The sides *pick up* the load. They transmit that load to the belt as a whole. And then, once more, the sides—and the sides alone—take hold of the driven pulley and deliver the power to it.

That is why you have always noticed that the sidewall of the *ordinary* V-belt is the part that *wears out first.*

That's Why the CONCAVE SIDE

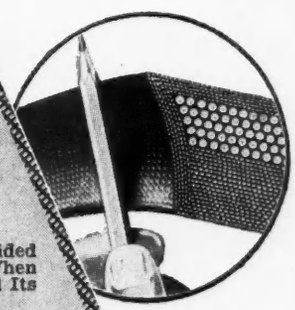
A GATES PATENT

Fig. 1

Straight Sided V-Belt

Fig. 1-A

How Straight Sided V-Belt Bulges When Bending Around Its Pulley



You can actually feel the bulging of a Straight-sided V-Belt by holding the sides between your finger and thumb and then bending the belt. Naturally, this bulging produces excessive wear along the middle of the sidewall as indicated by arrows.

Fig. 2

Gates V-Belt with Patented Concave Sidewall

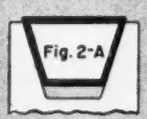


Fig. 2-A

Showing How Concave Side of Gates V-Belt Straightens to Make Perfect Fit in Sheave Groove When Belt is Bending Over Pulley.

No bulging against the sides of the sheave groove means that sidewall wear is evenly distributed over the full width of the sidewall—and that means much longer life for the belt!

Is IMPORTANT to You

Since the sidewall is the part that wears out first, anything that prolongs the life of the sidewall will naturally lengthen the life of the belt.

The simple diagrams on the left show exactly why the ordinary, straight-sided V-belt gets excessive wear along the *middle* of the sides. The diagrams show also why the Patented Concave Side greatly *lengthens the life* of the *sidewalls* of Gates Vulco Ropes. That is the simple reason why your Gates Vulco Ropes are giving you so much longer service than any straight-sided V-belt can possibly give.

The Concave Side is Even MORE IMPORTANT Now that SUPER VULCO ROPES *Are Available!*

Now that Gates *SPECIALIZED* Research has resulted in Super Vulco Ropes capable of carrying much heavier loads—fully 40% higher horsepower ratings—the sidewall of the belt is called upon to do even more work in transmitting these heavier loads to the pulley. Naturally, with heavier loading on the sidewall, the life-prolonging Concave Side is more important now than ever before!

The Gates Rubber Company

"The World's Largest Makers of V-Belts"

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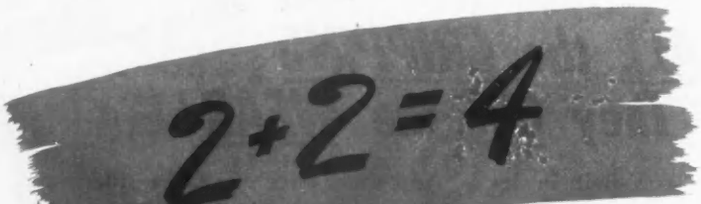
elevated pipes that had been perforated by a drill on the underneath side, forming two rows of outlets, as shown. Two such lines were supported at either end of the mud pump sump, and were elevated about five feet above ground level. Each perforated pipe was about 25 feet long and both were connected through a common manifold at one end.

When the mud became too hot and affected the physical characteristics of the drilling fluid, or contained trapped-in gas, the auxiliary or mixing pump was used to take the hot fluid from the settling pit and pump it through the perforated pipes which discharged it into the pump sump. The mud was cooled several degrees and much of the trapped gases were released, thus providing a drilling fluid of more desirable characteristics at a minimum of expense and trouble.



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Add up the qualifications of JP Rods and Liners. You'll find—JP uses top-quality mateiral . . . JP's expert oil country machinists know how to tool this equipment to exacting standards . . . JP "hardens" each and every JP Rod and Liner by a patented process and then subjects them to approximately 600 (or better) Brinell test.

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Made to A.P.I. Standards, JP Rods and Liners are available in all stock sizes (and special sizes) to fit any slush pump. For information on sizes and prices—ask for our New Catalog or give us your specifications.

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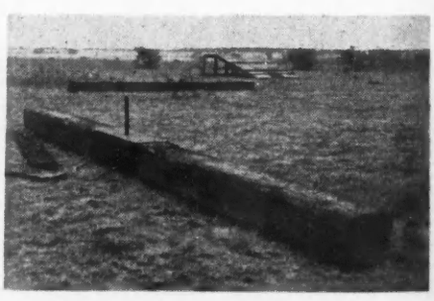
HOW TO—

Construct Bolster for Wide Equipment

To speed the handling and trucking of extra wide equipment such as derrick substructures and similar material while moving from one location to another, one company operating in New Mexico utilizes a bolster of unusually large dimensions. Instead of breaking down the equipment to smaller dimensions or using make-shift supports and bracing on the truck or trailer, a bolster some 30 feet long was built.

The bolster is made of a 16-inch square timber, in the center of which is attached the pin and a sheath of strengthening steel plate. The latter, made of three-eights-inch tank steel, is five feet long and completely surrounds the bolster at the center, the plate being welded together at the corners. The pin is a piece of 1¾-inch steel shafting which is run through the timber and welded to either side of the sheathing. The projecting portion is 18 inches long. Savings resulting from the ability to haul larger pieces of equipment have repaid the original cost of the special bolster many times over.



Exploration in the Dakota Basin

A COMPLETE and accurate summary of what has been done, who did it, what they were trying to accomplish in the Dakota Basin, the most neglected potential oil producing area of its size in the U. S., is here presented to the industry, currently engaged in a nationwide exploration campaign to replenish the country's diminishing oil reserves.

By DR. JOHN PAUL GRIES
Associate Professor of Geology
South Dakota School of Mines and Technology

THE Dakota Basin is the most neglected potential oil producing area of its size in the U. S. Despite exploration and drilling activity in all of the major basins in the Rocky Mountain area, there is record of only one geophysical party, and two or three small surface investigations in the entire Dakota Basin area in 1947.

Early Investigations

The presence of a structural basin in the western Dakotas was noted by exploration parties traveling up the Missouri River by steamboat as early as the middle of the last century. Geological investigations in the Black Hills area immediately following the discovery of gold in 1874 led to the working out of the stratigraphy and generalized structure of the southwestern edge of the basin, the only area where the marginal outcrop of the older beds are not concealed by younger outcrops or glacial drift.

Discovery of artesian water in the Dakota sandstone in the early 1880's resulted in the drilling of thousands of wells by farmers, ranchers, municipalities, and the several railroads which reached across the area within the three decades from 1880 to 1910. By the latter year, the eastern and southern flanks of the basin could be contoured with considerable accuracy. The great inventory of our national coal resources, made by the U. S. Geological Survey in the years immediately preceding the first world war, served to delineate fairly well the major surface features within the central part of the basin, and resulted in the discovery of the Cedar Creek anticline which forms much of the western edge of the basin. Structural features of the northern side of the basin were but slowly outlined, and the details of the entire basin are still far from complete. Currently, the central part of the structure in western North Dakota is called the Williston Basin; the north-plunging synclinal extension into South Dakota, the Lemmon Syncline; and the south-plunging trough north of the International boundary, the Moosejaw Syncline.

In the 1880's, oil was collected from seeps at several points along the west flank of the Black Hills, and sold at high prices to wagon-freighters and miners. Shallow drilling near the seeps was a natural sequence, and by the beginning of the first world war, several small fields had been developed along the extreme eastern edge of the Powder River Basin, on th west flank of the Black Hills uplift. These produced from formations known to underlie at least part of the area north and east of the Black Hills, and thus aroused interest in the oil possibilities of the Dakota Basin.

The first oil tests drilled in the Dakotas were confined to the small, sharp anticlines on the north, south, and east flanks of the Black Hills. The first of these known structures was drilled in 1904, the last one not until 1942. Most of these tests were locally financed, and nearly all were abandoned at depths of less than 1000 feet when artesian water was encountered in the Dakota or Minnelusa sandstones.

In the prosperous agricultural years following World War I, oil enthusiasm was high in the Dakotas. Much leasing was done, and perhaps 20 tests were started in the deeper parts of the basin before the depression and drought set in. A few of these were bona fide tests based on surface mapping, but most of them were drilled on local pride, or upon structures existing only in the minds of the promoters. Few of them were drilled deep enough to supply any stratigraphic information, and only a few of the operators appreciated the future value of accurate logs or carefully saved sample cuttings. Perhaps half a dozen deep tests were started during the decade following the crash of 1929.

A summary of the results of all drilling and exploration up to the beginning of the major play which started in 1938-39 can be summarized as follows:

(1) Only five wells which penetrated below the Dakota sandstones, not counting the relatively shallow wells east of the Missouri, or those close to the Black Hills.
(2) Reasonably good driller's logs on all of these.
(3) Usable sets of cuttings on four of these. Most of these were filed at State Surveys or schools.
(4) Generalized reports on the oil and and gas possibilities of the basin, issued by federal and state surveys. A few detailed surface studies of limited areas, conducted by the same agencies.

Exploration Within the Past Decade

The oil play which really started with the drilling of the California Company's Kamp 1 in 1937-38, spread quietly to the

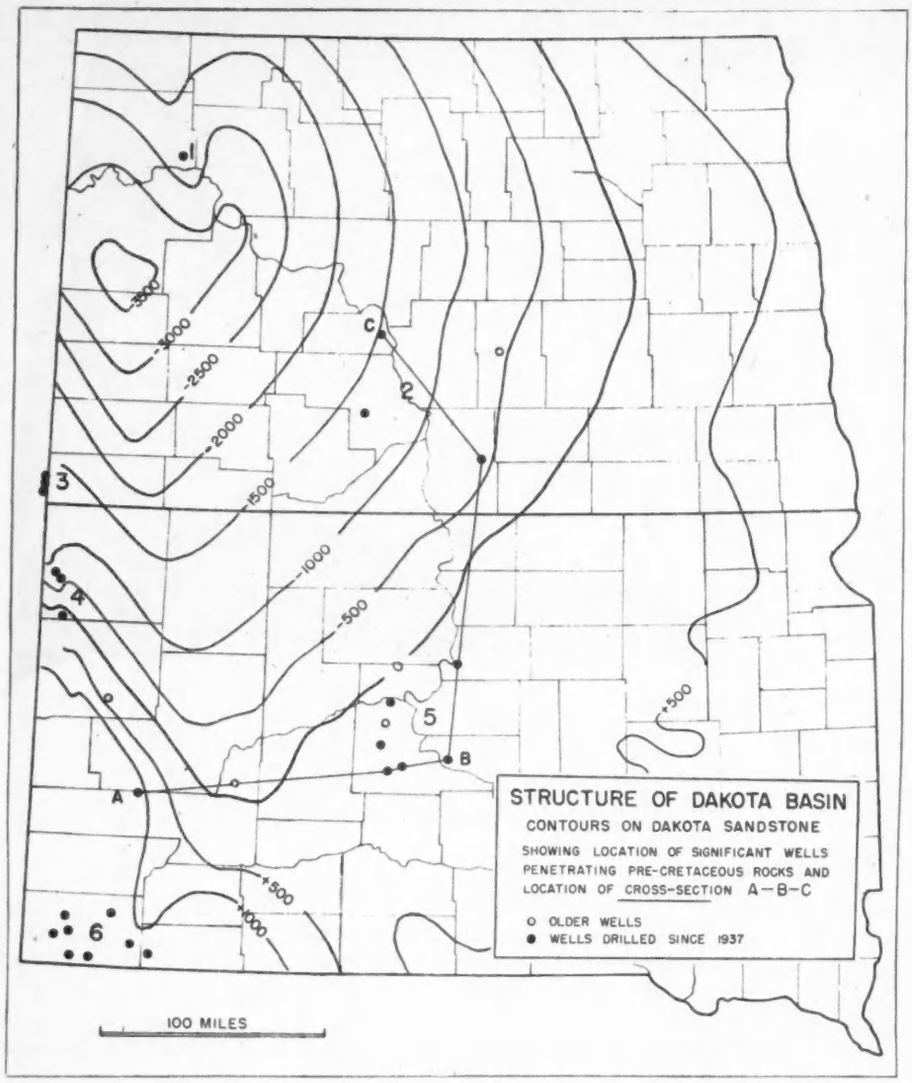


PLATE 1

entire basin in 1939, and was in full swing during the field seasons of 1940 through 1942. Most of the majors in the Mid-Continent and Rocky Mountain areas participated, as did several independents. Many of them established offices within the area. Geophysical and surface parties covered most of the unglaciated or lightly glaciated parts of the basin, and several million acres were consequently brought under lease. A limited but relatively expensive drilling campaign was undertaken. Restrictions on transportation and manpower caused a premature collapse of the field exploration program, though the drilling schedule, encouraged by tax money in some instances, was continued through 1944. Disappointing results from the few tests drilled led to the dropping of acreage by all but two or three of the major companies, and a comparable reduction in the amount held by independents.

Several other developments in the war and immediate post-war period are worthy of mention. These include (a) the drilling of several exceptionally deep water wells at military installations within the area; (b) extension of a shallow Montana gas field into southwestern North Dakota along the extension of the Cedar Creek Anticline; (c) development of a small gas field along the southern edge of the Black Hills in Fall River County, South Dakota; and (d) a geophysical and drilling program which tested the structurally high area extending southeast from the Black Hills to the Chadron Anticline in northwestern Nebraska.

Deep tests drilled in southeastern Montana in the years 1935-41 indicated that an east-west trough existed in that area during much of Paleozoic time. In addition to the formations represented in the standard Black Hills section, beds were recognized in these wells which are probable correlatives of strata known only in central Montana, in Manitoba, or in the upper Mississippi Valley area. The California Company's Kamp 1, drilled in Williams County, North Dakota, in 1937-38 to a total depth of 10,281 feet, encountered approximately 4000 feet of pre-Permian sediments the correlation of which could not be satisfactorily agreed upon. Subsequent drilling in both Dakotas has revealed the wide areal extent of these basin sediments. Most geologists now agree in assigning these extra beds to the Ordovician, Devonian and Upper Mississippian systems. The wells for which good records are available are so widely spaced, and so far from known surface or subsurface sections, that correlation of the individual formations within these systems has been difficult. Reference to the papers of Kline,[3] Seager,[4] Ballard,[5] Ehlers,[6] Hennen[7] and Laird[8], reveals the diversity of opinion as to correlation which has existed. Much of the difficulty is due to the rapid lateral changes which characterize these sediments.

Two types of potential oil structures have been anticipated within the basin. First, of course, is the anticlinal or domal structure, and secondly, the stratigraphic trap. The domal structures have long been known, and many of the earlier tests were located on real or fancied surface highs. Some of the deepest of the recent tests have also been put down on surface and geophysical highs.

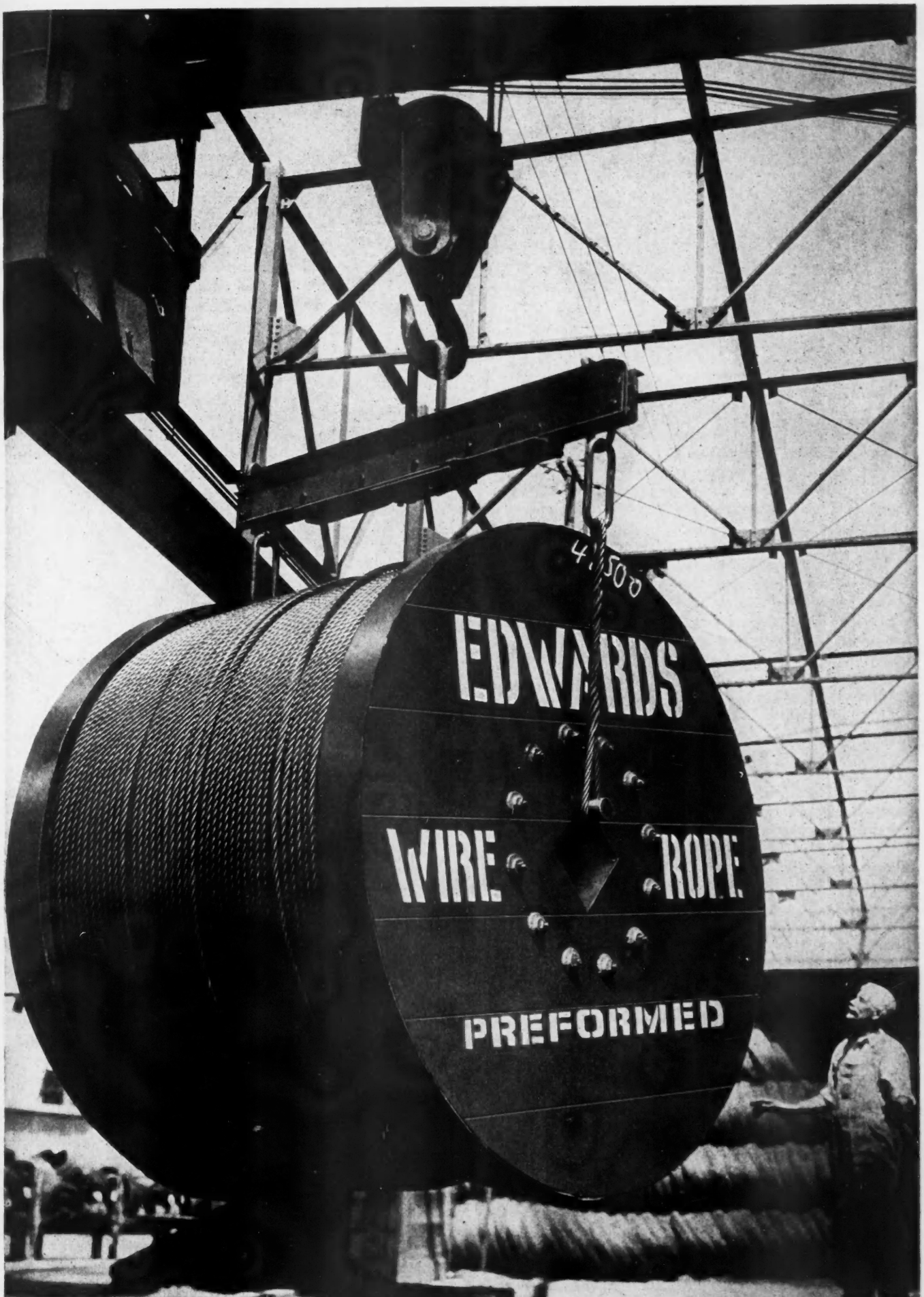
Although the presence of overlaps and pinchouts of sediments against the pre-Cambrian landmass which forms much of the eastern edge of the basin has been inferred for many years, no specific information has been available. Most of the east-west cross-sections extended eastward from the Black Hills, and showed the formations represented there, extending eastward beneath the basin, and wedging out by overlap or erosion in the east-central part of the state. Most of the sections were drawn to include the Standing Butte well in Stanley County, South Dakota. This well shows the loss of considerable section, but the early interpretations of the sample log differed much from recent correlations, and as a result the early cross-sections were very misleading.

Recognition within the last few years of an additional Ordovician section, and of Devonian and Upper Mississippian beds in the deeper parts of the basin, indicate that pinchouts of one type or another must exist not only along the eastern side, but actually nearly all the way around the margins of the basin. All active operators in the recent play were conscious of the existence and significance of these traps. However, surface geology is of little or no assistance, and geophysical data could not be interpreted with the degree of precision necessary to locate the pinchouts exactly. Several slim holes have been drilled for just such stratigraphic information.

Specific Areas of Exploration

The accompanying map of the basin shows that the important wells drilled within the last 10 years fall into six distinct areas (see Plate 1).

1. Nesson Anticline. This structure,



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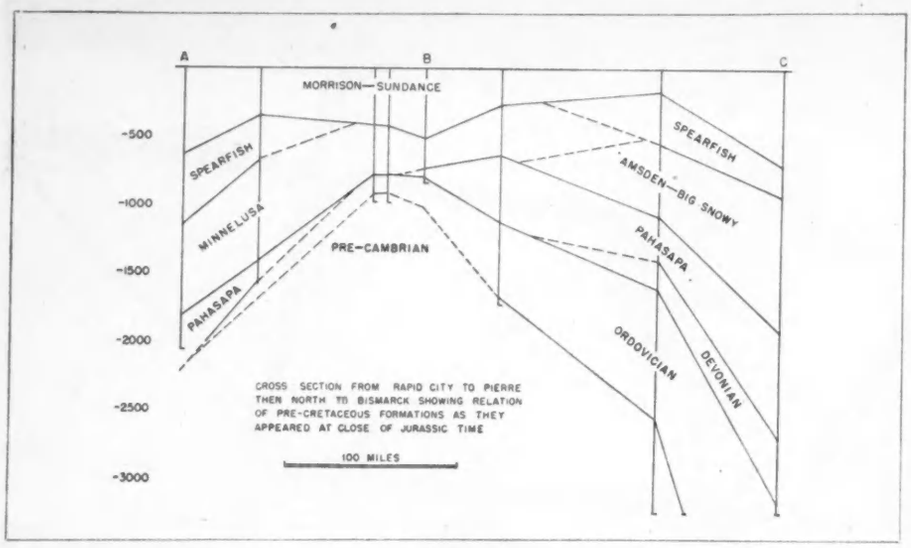


FIGURE 1

discovered in the course of coal investigations prior to World War I, is the largest surface feature within the deeper part of the basin. Two wells, very close together, have been drilled; the deeper California Company's Kamp 1 having bottomed in Devonian or Ordovician at 10,281 feet. Oil shows in the beds below 10,050 feet were not tested due to mechanical difficulties. Recent mapping by the North Dakota Geological Survey,[6] and additional geophysical work by one of the majors within the last year, suggest that this structure still may be regarded as one of the most favorable in the entire basin area.

2. Southeast extension of the Cedar Creek Anticline. The Montana-Dakota Utilities Company has succeeded in developing a shallow (1200-foot) Eagle sandstone gas field of small areal extent. Several deep tests across the line in Montana have had good shows in the Mississippian, Devonian and Ordovician sections,[3] but no commercial oil has been encountered.

3. South Central North Dakota. The first deep test in the area was The Prairie Oil and Gas Company's Armstrong 1, Kidder County. A section of shale and limestone below the Dakota series was originally correlated with the lower Paleozoic of the Winnipeg area by Kline.[5] This suggested that the pinching out of the Silurian-Jurassic sediments occurred to the west, and more or less localized the subsequent play in the central part of the state.

A tight slim hole by The Carter Oil Company in Morton County in 1940 apparently justified further exploration. Carter's Semling 1, Oliver County, drilled on a surface and subsurface high, showed a surprisingly complete section, comparable to, but thinner than, that in the Kamp. It was finished 19 feet into pre-Cambrian at a total depth of 8850 feet. No shows were logged, though interesting porosity was developed in the Mississippian, Devonian and Ordovician sections. A third test, the Carter-Northern Ordnance's Franklin Investment Company 1, Emmons County, was located far enough east so that some of the formations encountered in the Semling might reasonably have been missing. However, all age groups were represented, though they were somewhat thinner in most instances.

Unexplored Possibilities

On the basis of this subsequent drilling, Hennen[7] has suggested that Prairie Oil and Gas' Armstrong 1 in Kidder County actually bottomed in the Mississippian. This means that at least part of the pinchouts lie well to the east of the Missouri River, under the glacial drift, in an area which has been completely unexplored by deep drilling. Exploration of the eastern edge of the basin in this area, then, must involve much more geophysical work, and the drilling of numerous stratigraphic test holes.

4. The Camp Crook Anticline is a strong surface feature lying astride the South Dakota-Montana line on the western edge of the basin. A deep test by the States Royalty Petroleum Company in 1939-40 revealed not only the complete Black Hills section, but the presence of an upper Mississippian Big Snowy section, and a greatly expanded series of Ordovician beds. The well was dry, but encouraging shows were encountered in the Ordovician. In 1943, Carter and Northern Ordnance put down their Harding County School Land 1 about 1½ miles southeast of the previous hole. The Ordovician here yielded only sulfur water. The same operators then moved about 18 miles southeast, on the so-called Gustav structure, and drilled their Government 1 test. This encountered essentially the same section, and again tested sulfur water in the Ordovician at a total depth of 7038 feet. These three tests discouraged further drilling on the data at hand, but considerable acreage is still held in the area.

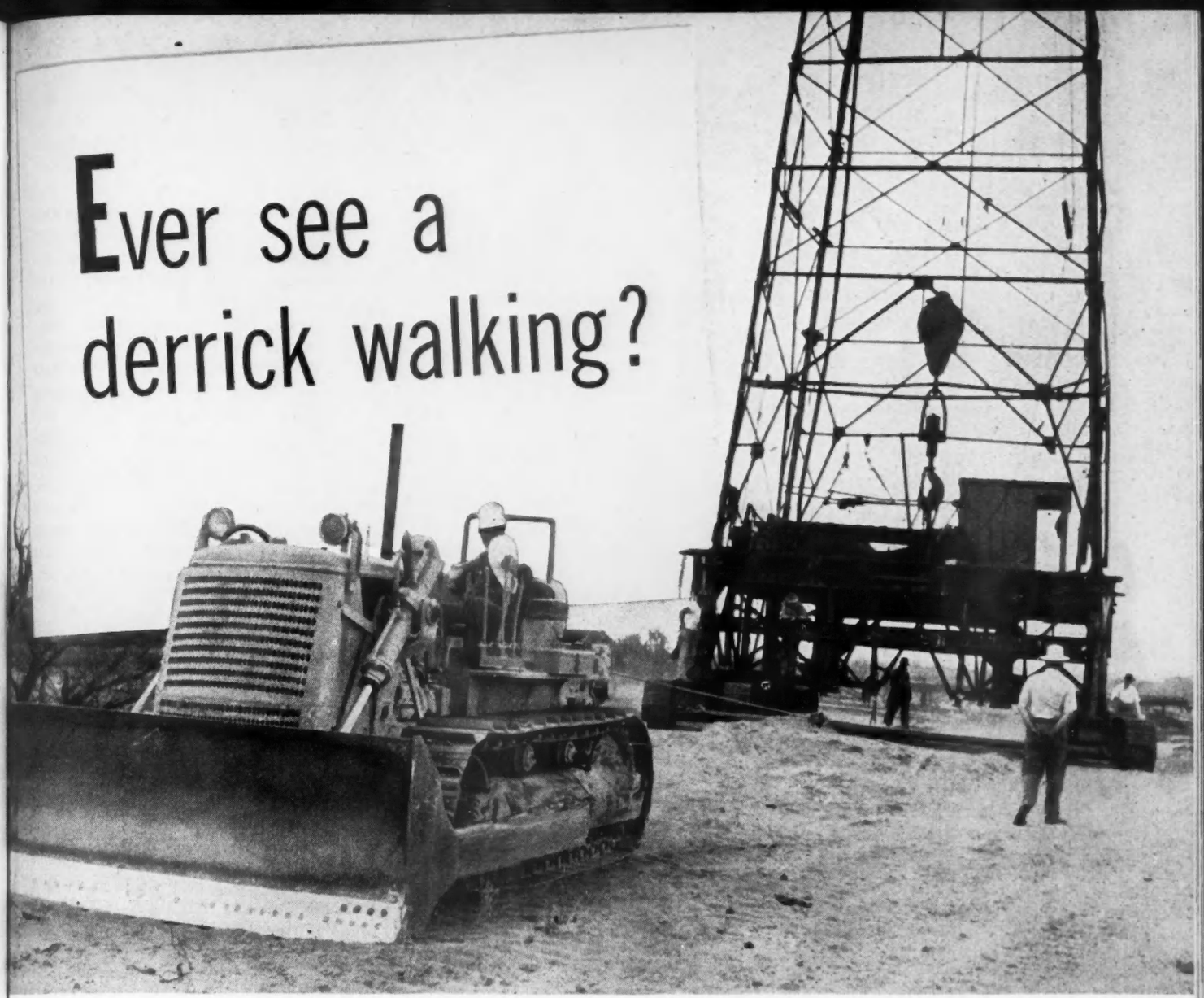
5. Central South Dakota. The presence of dry gas in the Upper Cretaceous beds of central South Dakota was early noted by artesian well drillers. The gas occurred not only in the sands of the Dakota group, but also in the overlying shales. The interest aroused by this gas culminated in the drilling of the Standing Butte test in Stanley County in the early 1920's. This pioneer well was drilled on a surface high, and bottomed in the Pahasapa (Madison) limestone at 3508 feet. Traces of dead oil were reported in the Pennsylvanian. Samples were originally interpreted to show each unit of the Black Hills section represented, though thinner and of somewhat different lithology than at the outcrop. Two stratigraphic tests by Carter company were drilled on surface highs in the same general area in 1940. The first was just east of the Missouri River, in Potter County; the second, a few miles north of the Standing Butte test, along the northern edge of Stanley County. Neither encountered oil shows, but both contributed greatly to the understanding of the stratigraphy of the area. In both tests, Pennsylvanian directly underlies the Sundance, with the Permian and Triassic missing. Presence of Upper Mississippian Big Snowy beds is still debatable, and makes correlation with the North Dakota wells uncertain. (In the accompanying cross-section, Figure 1, the Big Snowy is not shown in the South Dakota wells). All observers are agreed upon the presence of Ordovician beds immediately beneath the Pahasapa limestone.

A water well put down at the Pierre Airport in Hughes County in 1942 indicated a greatly thinned Pennsylvanian and Mississippian section lying directly below the Jurassic.

In 1944 and 1945, Phillips Petroleum Company, after detailed geophysical work, put down three stratigraphic tests in south central Stanley County. These tests indicated (a) great thinning of the Pennsylvanian to the southeast; (b) pinching out of the Pahasapa within the small area encompassed by the three holes; (c) rapid thinning and pinching out of the Ordovician within the same area; and (d) a corresponding rise in the elevation of the pre-Cambrian surface to the south. No shows were encountered, though porosity was present in the Minnelusa and in the Ordovician in the northernmost well. It is discouraging that such close delineation of these pinchouts revealed no justification for further drilling in the immediate area.

6. Region South of the Black Hills. Although this area may not be considered an integral part of the Dakota

Ever see a derrick walking?



Anchored by its tracks and 'dozer, this "Caterpillar" Diesel D7 Tractor, owned by R. C. Rumbaugh & Sons, Odessa, Texas, pulls a complete oil derrick across country by means of its Hyster towing winch.

MOVING a drill rig across country offers no problem to R. C. Rumbaugh & Sons, oil-field contractors. They simply put dual Athey truss wheels under the four corners of the rig, hook up to a "Caterpillar" Diesel Tractor with Hyster towing winch, and away they go. The 122-foot derrick is moved complete, without dismantling. Over loose Texas earth, where there are no roads, this husky puller moves the rig along at nearly two miles an hour!

The D7 is equipped with a bulldozer, and as soon as it delivers its load to the new location it's ready to go to work digging slush pits and doing other earthmoving jobs.

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Basin, two plays of considerable interest have taken place within the last few years. Woodward Oil, Inc., and associates have drilled 11 tests on the Chilson structure, a steep south-pitching nose with local closures at the south end of the Black Hills uplift. Several of these have been completed as small gas wells in the Newcastle (Muddy) sandstone of the upper Cretaceous at depths of 895 to 1145 feet. Two holes went deep enough to test the Pennsylvanian, and one of these continued into the Pahasapa. A typical Black Hills section was encountered, and one of the wells showed good saturation in the Morrison.

The Chadron Arch is the name applied to a broad, rather vaguely defined, structurally high area extending southeast from the Black Hills Uplift, to and beyond the vicinity of Chadron, Neb. Following a surface and seismograph study of the entire area, Amerada Petroleum Corporation put down a series of seven tests in 1945-46; four in South Dakota, three in Nebraska. These rather thoroughly tested the area, without encouraging results. East of a sharply defined line, the Pennsylvanian rested directly on the pre-Cambrian; west of the line a wedge of Pahasapa lies between the two and thickens to the northwest. Over the entire area, the Pennsylvanian is of remarkably uniform thickness, showing only a slow regional thinning to the north.

Summary of Results

The drilling andl exploration work carried on in the basin in the years 1938-1947 produced no commercial oil, but it did result in the accumulation of a mass of tangible information which more clearly defines the problems involved in further exploration. A summary and discussion of that information follows:

(1) Surface mapping and correlation, primarily in the Tertiary beds, was extended over wide areas. Some of this was done by government agencies, and has been published, but most of it was done by the oil companies, and is currently buried in their files. A notable exception is the work of Hennen.[7]

Experience has shown that by careful work, detailed surface mapping can be carried out not only in the Tertiary beds, but even in the dark marine shales of the upper Cretaceous.

(2) Much geophysical work was done by the various companies, and a good start on a magnetometer map of South Dakota has been made by the South Dakota Geological Survey. For the most part, geophysical records were good, but interpretation has been difficult because of lack of knowledge of subsurface conditions. Recent experience in making and interpreting seismograph records in the northern Rocky Mountain area should make a detailed re-study of some of this Dakota basin material very much worth while.

(3) Thirty-five wells were drilled to completion, for a total footage of 119,188 feet. This figure includes several slim holes, five exceptionally deep water wells, and 11 gas tests south of the Black Hills. It does not include a number of shallow (1200-foot) Eagle sand gas wells in Bowman County, North Dakota.

These tests have revealed several thousand feet of additional section, assigned to the Ordovician, Devonian and Upper Mississippian systems. Good zones of porosity have been encountered in each. The number of potential structural and stratigraphic traps is consequently increased, and the area over which they may occur is greatly expanded.

(4) Sample cuttings were saved on all 35 wells. Cuttings from the 14 which were drilled by major companies went through regular sample cuts and received wider distribution, but nearly all are on file within the area at the North Dakota Geological Survey at Grand Forks, the South Dakota Geological Survey at Vermillion, or at the South Dakota School of Mines and Technology at Rapid City.

(5) Electric logs were run on at least 18 holes. About two-thirds of these received general distribution. Many are on file at the institutions mentioned above; the most nearly complete file is at Rapid City.

(6) A limited number of water analyses were run; the samples ranging from fresh water to salt and hot sulfur water. Although the low mineral content of most of these waters has been discouraging to operators accustomed to the brines of the Mid-Continent area, Crawford* has shown that many of these are quite comparable to waters encountered in the oil producing areas of Wyoming and Montana.

Future Prospects

Present and future search for oil in the Dakota basin will concentrate on the location of both structural and stratigraphic traps involving particularly the Ordovician, Devonian and Upper Mississippian sections which have been discovered within the deeper parts of the basin.

Additional deep tests, looking for the porous zones in these beds, undoubtedly will be undertaken on such major structural features as the Camp Crook, Cedar Creek and Nesson anticlines. At the same time, further testing of the relatively shallow structures immediately north and south of the Black Hills can be expected, both by major companies and by small operators.

However, the greatest hope for the basin still lies in the location of stratigraphic traps involving the Ordovician, Devonian, upper Mississippian, and to a lesser extent, the Pennsylvanian beds. The Ordovician must pinch out at least around the southern margin of the basin, and the Devonian and Upper Mississippian nearly all the way around. Structurally high areas along the zone of pinchout of any of these formations should offer excellent conditions for oil accumulation. Admittedly, locating such prospects will be a slow, expensive process, involving extensive geophysical work, and the drilling of numerous stratigraphic tests. The area involved is tremendously large. The deeper part of the basin, which is probably underlain by Ordovician, Devonian or upper Mississippian, has an area, within the two Dakotas alone, of roughly 66,000 square miles. Fifteen deep tests have encountered these beds, for an average of one test per 4400 square miles. It is obvious that only the barest start has been made, and that as the search for oil constinues to be intensified, the Dakota basin will be due for another, much more thorough exploration program.

* This point was emphasized during discussion following presentation of a paper entitled "Waters of Producing Fields in the Rocky Mountain Region," by James G. Crawford, at the regional meeting, American Inst. Min. and Met. Engineers, Denver, Colorado, September 28-October 2, 1947.

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Effect of Added Nitrogen on Compressibility of Natural Gas

Part 1

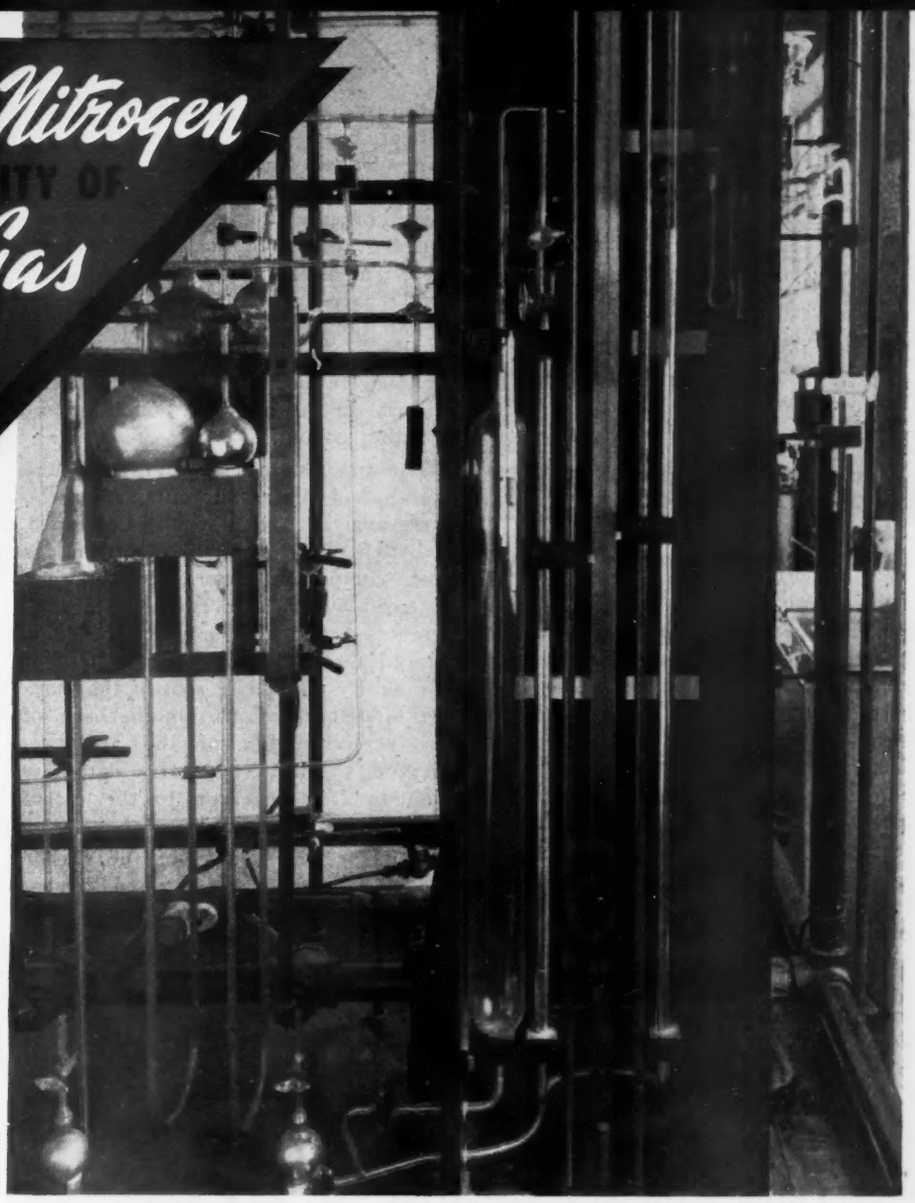

FIGURE 1. Baro-buret for accurate measurement of subatmospheric pressures.

By C. K. EILERTS,
H. A. CARLSON and
N. B. MULLENS

WHEN DEFINITE volumes of natural gas and pure nitrogen at the same pressure and temperature are combined, the volume of the mixed gases is greater than the sum of the volumes (additive volume) of the separate gases. Methods for computing compressibility factors which are satisfactory for natural gases containing little nitrogen require correction before they can be used for natural gases which are high in nitrogen. Additive volume correction factors have been determined experimentally in the temperature range 32° to 280° F. at pressures up to 5000 pounds per square inch on natural gas mixtures containing up to 18 percent nitrogen. As a result of the investigations, gas-volume corrections amounting to as much as 5 percent at low temperatures and at high nitrogen concentrations can be made with an accuracy that is consistent with the accuracy possible in estimating the compressibility of hydrocarbon components.

Of the authors, Eilerts is senior physical chemist, Bureau of Mines, Bartlesville, Okla.; Carlson formerly was associate petroleum chemist, Bureau of Mines, Bartlesville; and Mullens is assistant petroleum engineer, Bureau of Mines, Bartlesville.

NUMEROUS methods have been devised for computing the compressibility factor of a natural gas from its composition. Most of these are based on correlations of the properties of the hydrocarbon components of the gas. Such methods provide dependable solutions for low nitrogen gases because the molecular structures and physical characteristics of the paraffin hydrocarbon components that predominate in a natural gas are related. Nitrogen, a common component of natural gas, is however, chemically unlike hydrocarbon components and has different compressibility characteristics. Consequently, if nitrogen is present in a natural gas in a high concentration, computing methods that give consideration to its nature must be used to estimate reliably the compressibility of the gas of which it is a part.

This report presents the experimental results obtained in measuring the compressibilities of a low-nitrogen-content natural gas and of two mixtures of the natural gas with added nitrogen. Data secured within the temperature range 32° to 280° F at pressures up to 5000 pounds per square inch indicated that, when definite volumes of naturally occurring hydrocarbons (natural gas) and of pure nitrogen measured at the same pressure and temperature were combined, the volume of the mixed gases is greater than the sum of the volumes (additive volume) of the separate gases. The sum of the volumes of the physically separate gases and the volume determined experimentally after combination of the gases differed by as much as 5 percent, depending upon the pressure, temperature, and concentration of nitrogen involved. Values of this fractional volume difference (additive volume correction factor) have been evaluated as a function of the controlling variables.

Data available in the literature on the compressibility of nitrogen also have been summarized in a convenient table and chart, and a method is shown for using these data to estimate the compressibility of gases containing nitro-

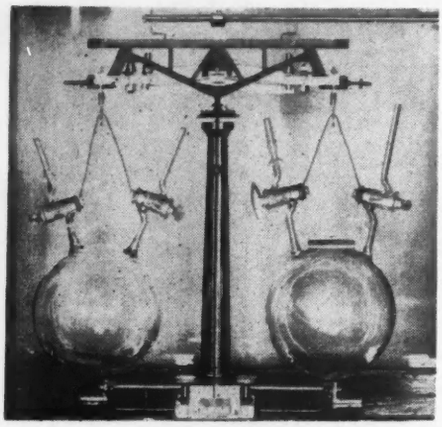

FIGURE 2. Glass flasks for weighing gases.

gen. The method involves computing the volume of the hydrocarbons and the volume of the nitrogen separately and correcting the sum of the volumes by means of the additive volume correction factor. Values of the additive volume correction factor for different pressures and temperatures were obtained from the results of the experimentation. The compressibility factors of natural gases containing up to 20 percent nitrogen may be computed with an accuracy that is comparable with the accuracy possible in estimating the compressibility of the hydrocarbon components alone.

Natural Gas Used

The gas used in the investigation was obtained from an oil-gas separator at a flowing well in the Tepetate, Louisiana, oil field. The gas was produced with a hydrocarbon liquid that had a gravity of 38° API in the stock tank. The separator was operated at a pressure of 90 pounds per square inch absolute and a temperature of 46° F. while the gas was being withdrawn from it and stored in 1.5-cubic-feet-capacity, steel cylinders. In the laboratory, carbon dioxide was removed from the gas before it was used in any of the experimental work. Aside from the small concentration of naturally occurring nitrogen (0.69 percent by volume), the gas used was strictly hydrocarbon material.

The composition of the gas was determined by low-temperature fractional distillation. The equipment (1, p. 12)* which was used for the distillation analysis included two fractionating columns operated in series. Fractions of the gas were prepared in the first column, and the fractions were further divided into the components identified by their vapor pressures in the second column.

Three different analyses of the gas were made and the averages of the results are reported in Column 2, Table 1. The nitrogen content of the gas was calculated from the specific volume of the nitrogen-methane fractions determined by means of the glass weighing flask. The isomers of hexane and heptane reported in Column 2 are identified in Column 1 by their vapor-pressure ranges at the temperature of the melting ice used as the refrigerating material in the condenser on the fractionating column.

The precision uncertainties of the averages of the results obtained in the three analyses are shown in Column 3, Table 1. The uncertainties given for each component represent a quotient obtained when the average of the differences (residuals) between the three analytical results and their mean was divided by the square root of the number of determinations. On the basis of the reproducibility of the analytical method, the last figure of a datum in Column 2 is uncertain to the extent expressed in Column 3.

The specific volume of the carbon dioxide-free gas was determined by use of a glass weighing flask. The mean result of 13 determinations was 21.200 ± 0.005 cubic foot per pound at a pressure of 14.4 pounds per square inch absolute, and a temperature of 75° F. The average difference between this mean value and the individual measurements (average residual) was ± 0.018 cubic foot per pound. The precision uncertainty of the mean (± 0.005 cubic foot per pound or ± 0.02 percent) was determined in the general way described for computing values appearing in Column 3, Table 1. Compared to dry air under the same pressure and temperature, the gas had a specific gravity of 0.649.

Table 1

Composition of separator gas and of the mixtures containing added nitrogen

1	2	3	4	5
	MOLE FRACTION			
	Separator Gas		Gas Containing Indicated Mole Fractions of Added Nitrogen	
COMPONENT	Average of 3, Analyses[1]	Indicated Precision Uncertainty[2]	0.07907	0.18280
Nitrogen	0.0069	0.0006	0.0855	0.1884
Methane	.8771	.0007	.8077	.7169
Ethane	.0649	.0001	.0598	.0530
Propane	.0322	.0002	.0297	.0263
Isobutane	.0076	.0004	.0070	.0062
Normal butane	.0058	.0006	.0053	.0047
Iso pentane	.0021	.00007	.0019	.0017
Normal pentane	.0012	.00013	.0011	.00099
135-56 hexanes	.00070	.00004	.00063	.00058
56-35 hexanes	.00036	.00003	.00033	.00029
35-17 heptanes	.00034	.00004	.00031	.00028
17-11 heptanes	.00012	.00003	.00011	.00010
Octanes plus	.00068	.00004	.00062	.00056
	1.00000		1.00000	1.00000

[1] The volumes of the three gas samples analyzed averaged 0.94 cu. ft.

[2] The average residual X_a may be computed by multiplying numbers in this column by 1.73. Two of the 39 residuals determined by the three analyses were equal to $1.6X_a$, 11 were in the size range $1.1X_a$ to $1.5X_a$ and all others were equal to or less than $1.0X_a$.

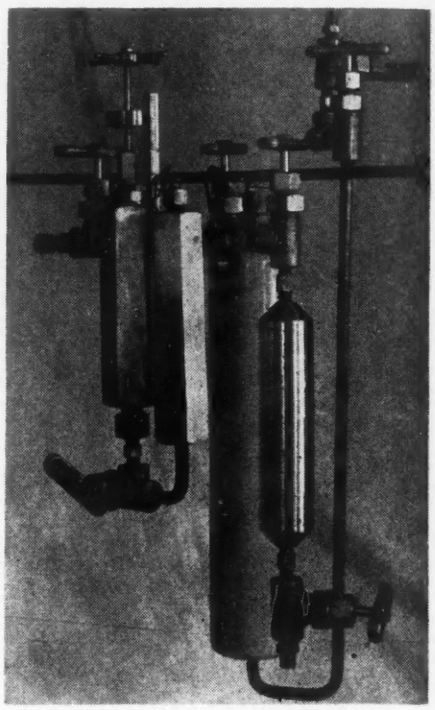

FIGURE 3. Steel pycnometer assembly for determining the compressibility of gases.

Nitrogen Used

Nitrogen gas of the grade referred to commercially as "99.6 percent purity, water-pumped nitrogen" was used in the investigations. This nitrogen was passed through calcium chloride to remove any water vapor that it might contain before it was used in tests. To obtain a measure of the purity of the dried nitrogen, its specific volume was determined by use of the weighing flask. The mean for four determinations was 886.54 ± 0.36 cubic centimeters per gram at a pressure of 14.4 pounds per square inch absolute and a temperature of 75° F. Using this measured value of the specific volume and compressibility data from the literature for pure nitrogen, it was calculated that the specific volume of the nitrogen at a pressure of one atmosphere and a temperature of 32° F. would be 798.62 cc. per gm. In their review of published data Smith and Taylor (2, p. 2112) reported that the volume of pure nitrogen at one atmosphere pressure and 32° F. is 799.55 cc. per gm. The difference in volumes, 799.55 cc. — 798.62 cc. = 0.93 cc., is in a direction indicating that the nitrogen may have contained a trace of a heavier gas such as argon or neon.

Another test of the purity of the nitrogen was made by determining its compressibility factor at a pressure of 1400 pounds per square inch absolute and a

* Figures in parentheses refer to citations at the end of this report. Page and figure references within the parentheses represent those in the citation.

temperature of 75° F. The mean of the results of two determinations of the factor, obtained by using a pycnometer assembly, was 1.0195 with an average deviation of ± 0.0002. A search of the literature for data on the compressibility of pure nitrogen at this pressure and temperature indicated that a factor value of 1.0177 represented the average of the results of a number of investigators. The difference in the two values, 0.17 percent, was not considered to indicate a significant impurity and the nitrogen was used in the investigations.

The datum, 799.55 cc. per gm. (12.807 cubic feet per pound), reported by Smith and Taylor for the specific volume of nitrogen at 32° F. and one atmosphere of pressure was used in handling data from the literature on nitrogen and in all computations of compressibility required in this investigation.

The gas constant for nitrogen was computed by means of the equation used to relate the values of pressure, temperature and the volume of one pound of a gas,

$$\frac{Pv}{ZT} = b \quad - - - - - - - \quad 1 \quad ;$$

where,

P = pressure, lb. per sq. in. abs.,
v = specific volume of the gas, cu. ft. per lb.,
Z = compressibility factor, a dimensionless quantity characteristic of a given gas and determined as to value by pressure and temperature. The compressibility factor is assigned unit value at zero pressure.
T = temperature, ° F. abs.,
b = gas constant and is the limit value of the function Pv/T as the pressure approaches zero. The engineering units of the constant b are,

$$\frac{\text{lb. per sq. in. abs.} \times \text{cu. ft. per lb.}}{^{\circ}\text{ F. abs.}}$$

The values from the literature for the properties of nitrogen at a pressure of 14.696 lb. per sq. in. abs. and a temperature of 32° F. were substituted in equation 1 with the result,

$$b = \frac{Pv}{ZT} = \frac{14.696 \times 12.807}{0.99955 \times 491.6} = 0.38304$$

Apparatus

A detailed description of the equilibrium cell used for making the P-V-T measurements of fluids at high pressures has been given in a previous publication, (3). Briefly, the cell is a cylindrical vessel (2.000 inches inside diameter) mounted with the axis vertical and of such length that it will accommodate a fluid sample expanded to a volume of 800 cc. (0.0282 cubic feet). A contained hydrocarbon sample is agitated with an assembly of four vertical rods mounted on a drive shaft which enters the bottom of the cell through an especially designed packing gland. The volume of the sample is varied by means of mercury which may be injected into or removed from the cell as required. Pressures within the cell are measured with a piston gauge. The temperature of the oil bath surrounding the cell is controlled to ± 0.05° F. by a relay assembly which includes a thermocouple, a sensitive reflecting-galvanometer and a photoelectric relay.

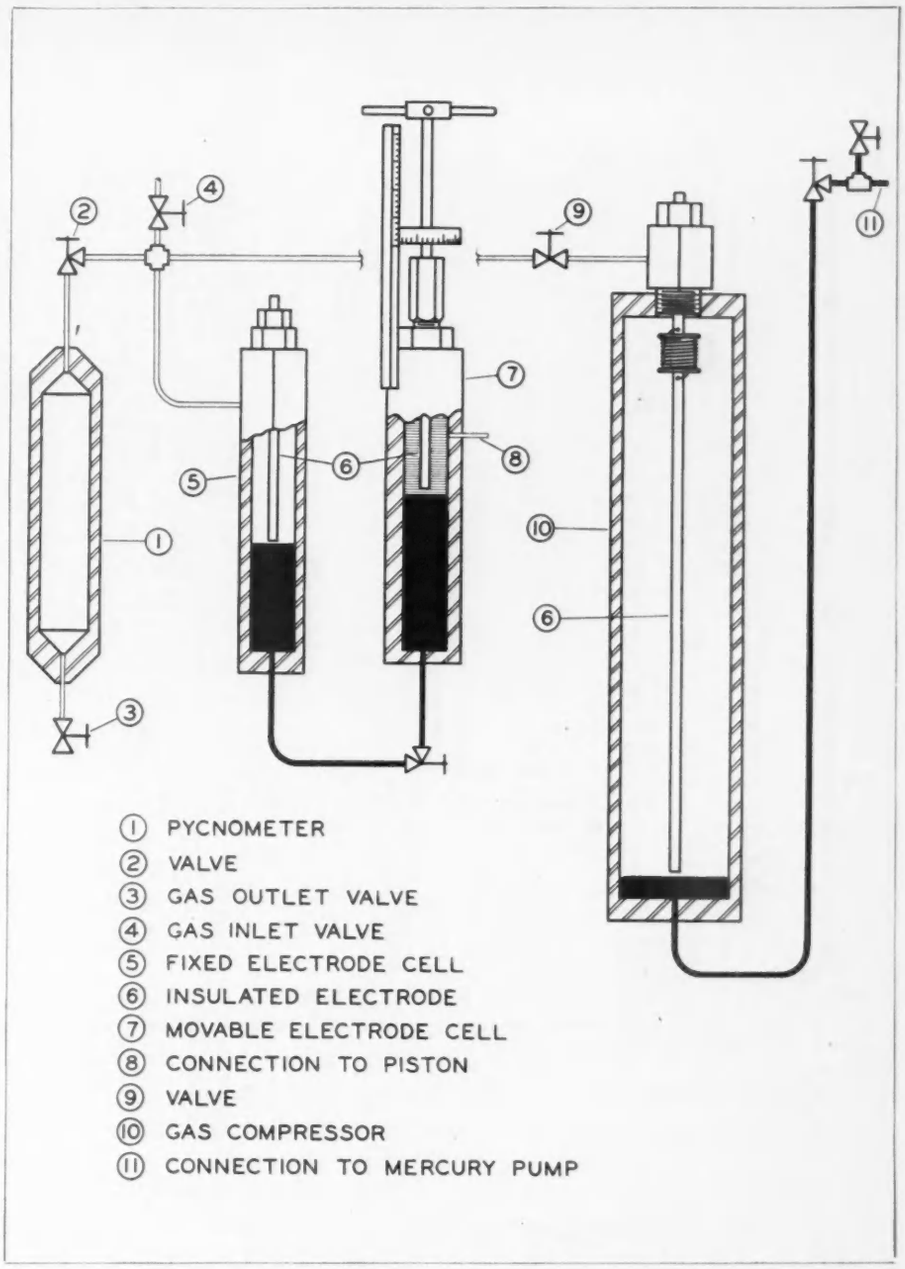

FIGURE 4. Schematic pycnometer assembly for measuring a compressibility factor of a gas.

Gas samples were transferred from the equilibrium cell to a 12-liter glass flask for specific-volume measurements at subatmospheric pressures. Such measurements were required for determining the limit value of the function Pv/T as the pressure approached zero. The glass flask, its mountings, and means of temperature control also have been described previously (4, p. 45).

The pressure exerted by the gas in the glass flask was measured by means of the baro-buret (1, p. 12). Figure 1 is a photograph of this manometric device. The gas pressure is exerted on the mercury surface in the left column of the U-tube, and the space over the mercury in the right column is evacuated. The difference in the levels of the mercury in the columns is the measure of the gas pressure. The levels are read with an accuracy of ± 0.1 mm. by means of a vernier on a steel scale.

The specific gravity of the hydrocarbon gas at atmospheric pressure was determined by weighing the gas in a glass flask. Figure 2 is a photograph of two glass flasks of approximately equal volume (490 cc.) suspended from the arms of a sensitive gravimetric balance. The flask in which the gas was weighed is suspended from the right arm of the balance and has attached to

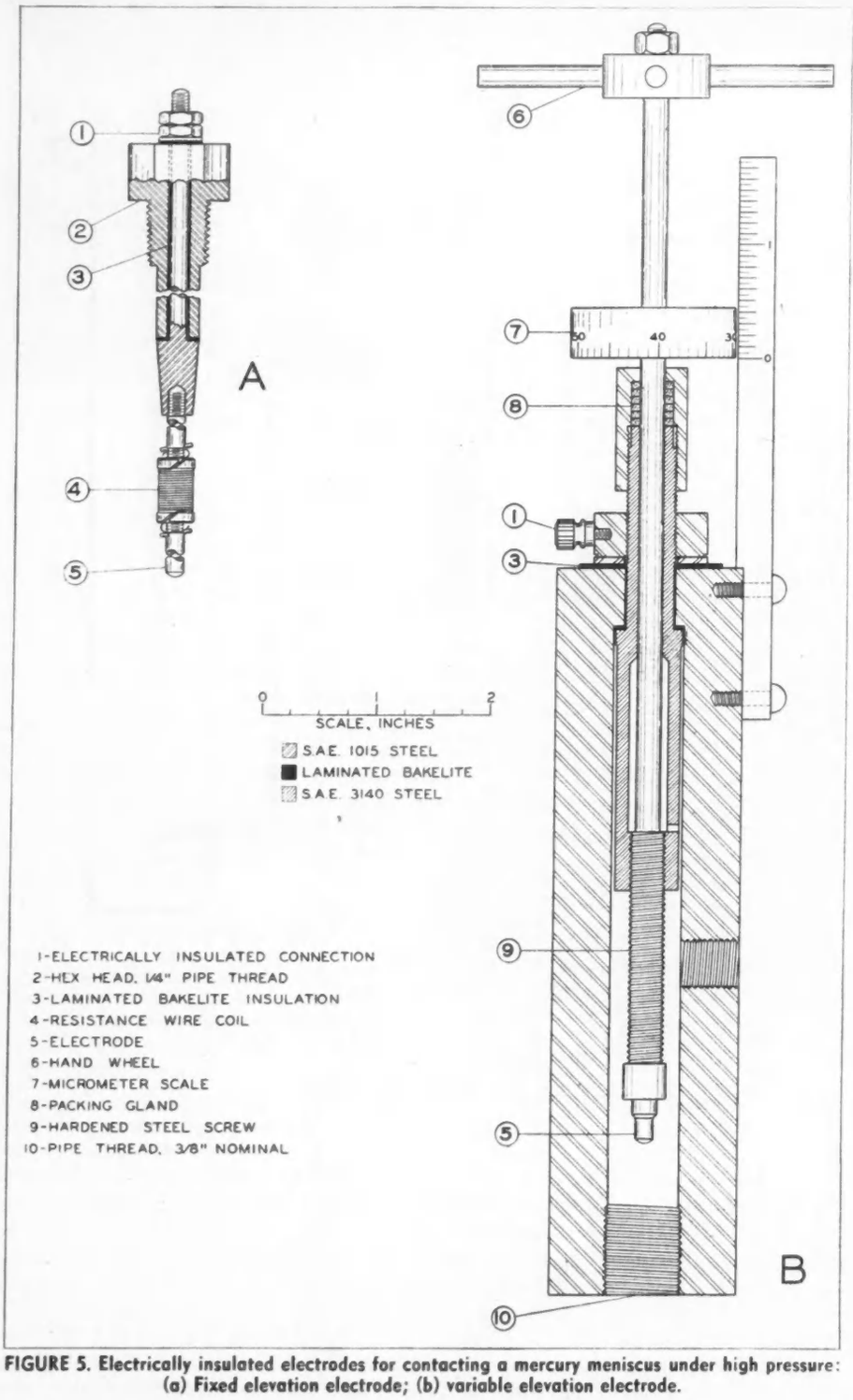

FIGURE 5. Electrically insulated electrodes for contacting a mercury meniscus under high pressure: (a) Fixed elevation electrode; (b) variable elevation electrode.

it a pan on which the weights are placed. The volume of this flask has been determined accurately. The flask suspended from the left arm of the balance is a tare for the weighing flask and has the important function of displacing the same volume and weight of air as the weighing flask. The weighing flask first is evacuated and then balanced against the tare flask, which may contain any gas and is closed throughout the procedure. The evacuated flask then is filled with the gas to a pressure approximately atmospheric, which is measured accurately by means of the baro-buret.

The flask and the gas it contains are maintained at a constant temperature by means of an air bath while the pressure of the gas is becoming stabilized preparatory to measurement. When the weighing flask is closed and again placed on the balance, the mass of the gas contained in the flask at the measured pressure and temperature is indicated by the decrease in the weight required to balance the gas-filled flask against the tared flask. The changes in the buoyancy of the atmosphere, which may occur while the specific gravity determination is in progress, affect equally the flasks suspended from the opposite ends of the beam of the balance. Individual determinations of the specific gravities of gases are subject to an uncertainty of $\pm$ 0.08 percent.

The investigation of the compressibility of nitrogen and natural-gas mixtures was expedited by using a simple steel pycnometer assembly in place of the equilibrium cell. This assembly was designed for measuring conveniently and accurately the volume of a gas sample at a controlled pressure and temperature. Figure 3 is a photograph of the assembly used for measurements of gas under pressure. In making compressibility measurements, each gas sample was compressed into the pycnometer, measured under a pressure of 1400 pounds per square inch absolute at a temperature of 130° F. and then expanded into the 12-liter glass flask for measurement at a subatmospheric pressure. The PVT data obtained provided one compressibility factor on each sample used. Auxiliary equipment, including a piston gauge, a constant-temperature oil bath, the 12-liter glass flask, and the baro-buret, were used with the steel pycnometer assembly.

Figure 4 shows schematically the parts of the pycnometer assembly; however, the indicated volumes of the vessels that comprise the assembly are not in their true relative proportions. The gas to be tested is taken through valves 4 and 9 into compressor 10, which is fitted with an electrode that indicates the position of the mercury surface when an electrical contact is made or broken. The gas then is compressed and displaced by mercury into pycnometer 1 and fixed electrode cell 5. The introduction of additional gas and the compression procedure is repeated, if necessary, until the desired pressure in the pycnometer is attained approximately. Valve 9 then is closed, and gas pressures are subsequently adjusted by raising or lowering the mercury surface in fixed electrode cell 5. Positions of the mercury levels in cells 5 and 7 are controlled by means of oil movement actuated by a screw on the piston gauge connected to movable electrode cell 7 at opening 8. The difference in mercury levels in cells 5 and 7 is determined by the screw-mounted contact on cell 7. When the gas pressure in pycnometer 1 has been adjusted accurately to the desired value and the bath in which the entire assembly is suspended is at the required temperature, valve 2 is closed. The assembly then is removed from the bath, and the gas in the pycnometer is expanded into the 12-liter flask through valve 3 for measurement at a subatmospheric pressure.

Scaled drawings of the fixed and movable electrodes used in the pycnometer assembly are shown in Figure 5. The parts of the electrodes must be

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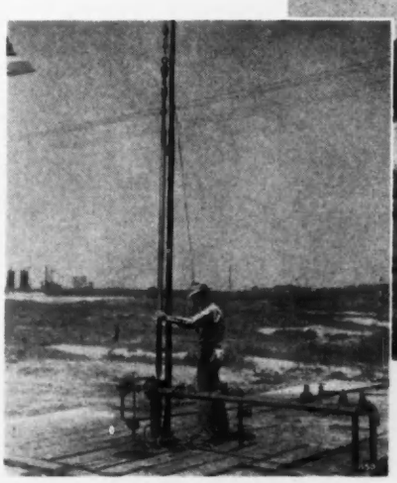

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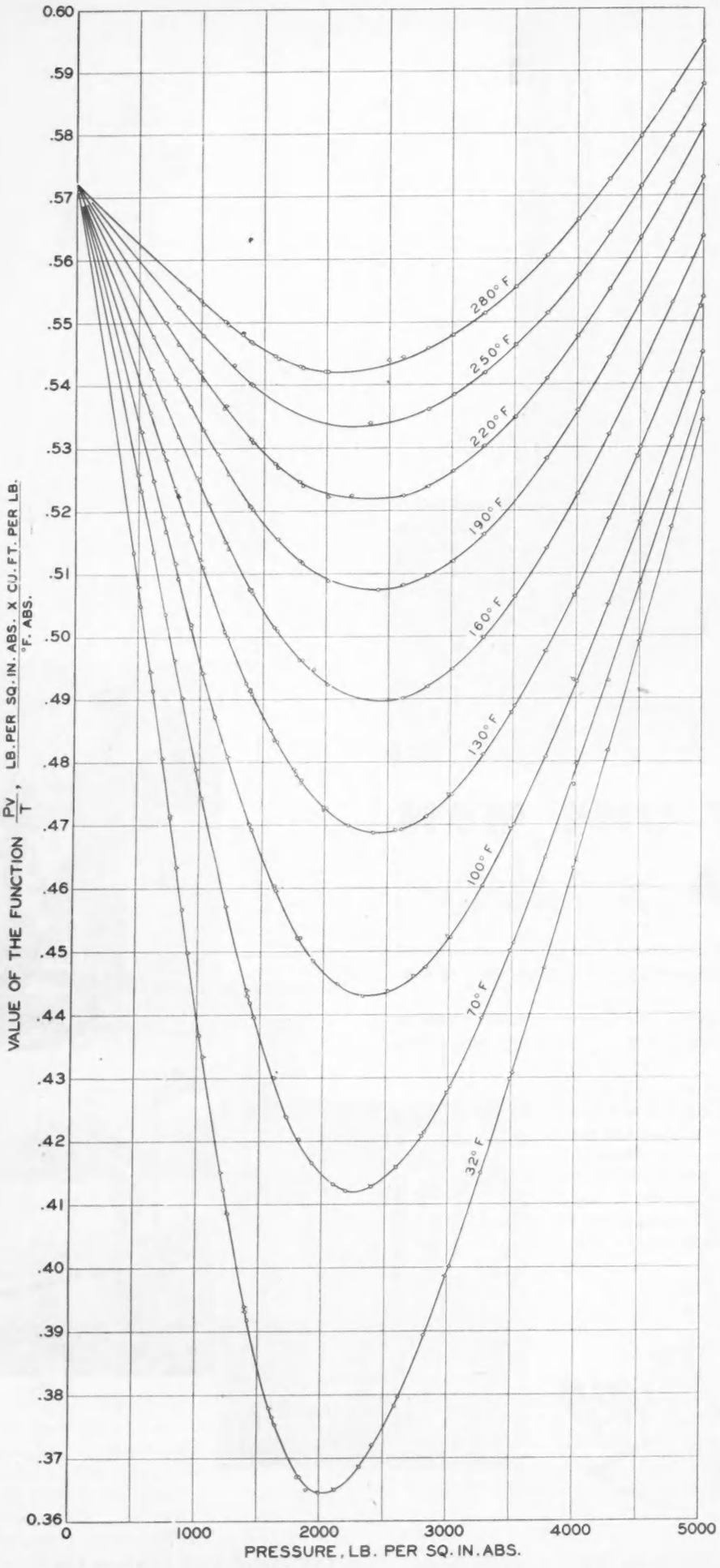

FIGURE 6. Specific volume data for a tepetate separator gas.

machined but are of simple construction. Other parts of the assembly are standard pipe fittings and electrically welded pressure vessels. The volume of the pycnometer is known to 0.04 cc. Using the pycnometer assembly for high-pressure measurements and the 12-liter glass flask for low-pressure measurements, the ratios of values of the function PV/T for the hydrocarbon gas were determined a number of times, results indicating that a single determination of the ratio was subject to precision uncertainty of 0.17 percent. This simple equipment is well-suited for determining a compressibility factor of a gas sample; it cannot, however, be used for determining the compressibility of two-phase fluids.

The statements in this report regarding the figure of uncertainty of a datum usually refer to precision or reproducibility rather than to absolute accuracy. It is difficult and to some extent impracticable to define the accuracy of a measure of a property of a system, if the composition of the system is not known with commensurate accuracy. However, the following statements regarding the accuracy of the instruments used in the experimental work will indicate to some extent the absolute accuracy of the measures of the properties given in this report.

The piston gauge used for measuring pressures had a capacity of 6000 pounds per square inch and was fitted with a motor-driven turntable that rotated the piston and weights continuously. Before the tests, the gauge was compared with standard piston gauge B.M. No. 3 at the Amarillo, Texas, Helium Production Plant of the Bureau of Mines over a pressure range up to 4000 pounds per square inch, results indicated that the accuracy uncertainty of 15 comparisons averaged ± 0.066 pounds per square inch.

Gauge B.M. No. 3 had been calibrated indirectly against mercury columns and was considered to be accurate to ± 0.05 pounds per square inch at a pressure of 4000 pounds per square inch. It is estimated, therefore, that the accuracy uncertainty applying to use of the piston gauge for measuring pressures was less than ± 0.1 pound per square inch and averaged less than 0.02 percent of the pressure measured.

Temperatures were measured by means of 9 mercury-in-glass thermometers graduated in 0.1° F. and each covering only 30° F. of the entire range of experimental temperatures. The thermometers were calibrated to 0.1° F. by the National Bureau of Standards.

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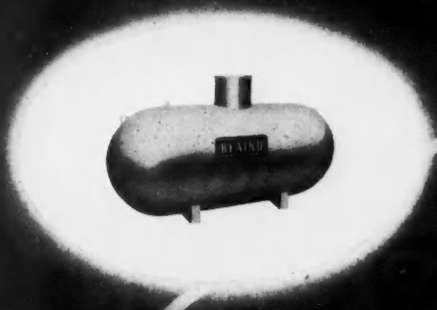

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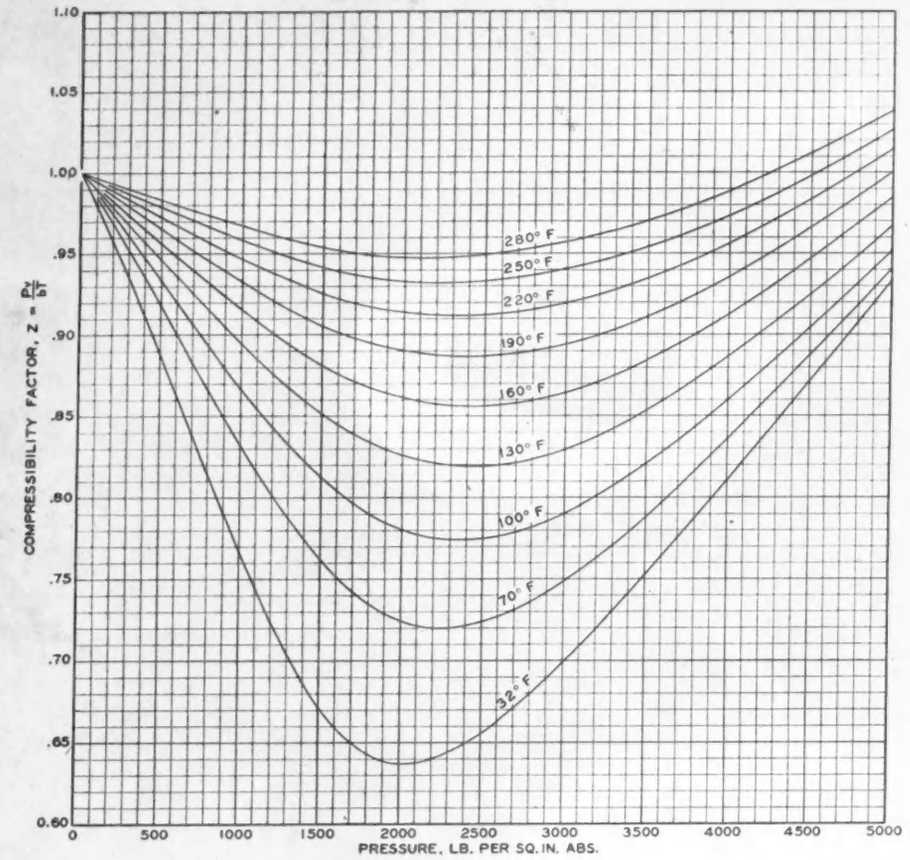

FIGURE 7. Compressibility factors for a tepetate separator gas.

Auxiliary scales at either 32° F. or 90° F. permitted checking the thermometers against the melting point of ice or the transition point of sodium sulfate to determine if secular changes have affected the readings of the thermometers at given temperatures. Temperatures measured by means of the thermometers were considered to be accurate to ± 0.1° F. or approximately ± 0.02 percent of the absolute temperature. The temperature 32° F. was obtained by filling the bath with chipped ice and water. The bath liquid for the temperature 70° F. was usually water and for the higher temperature was oil. In each case the liquid was circulated rapidly so that a temperature measured by a thermometer represented uniform bath temperature and the temperature of the submerged cell.

The volumes of the equilibrium cell and of the mercury displacement meter (3, p. 16) were determined by weighing measured volumes of mercury withdrawn from them at constant temperature and pressure. The calibrations were estimated to be accurate to ± 0.05 cc. In using these vessels, corrections were made for volume changes resulting from changes in pressure and temperature. Mercury levels were located by means of an electrode through which passed only enough current to actuate an electronic relay so that the electrode ends remained clean and functioned reliably for indefinite periods. The accuracy uncertainty pertaining to use of the equilibrium cell and the displacement meter was estimated to be ± 0.09 cc. or ± 0.09 percent of the total volume of a sample under high pressures and ± 0.013 percent of the volume of a sample under low pressures.

The accuracy uncertainty of values of the function PV/T is the square root of the sum of the squares of the uncertainties applying to each of the variables and is estimated to be ± 0.032 percent at low pressures and 0.094 percent at high pressures. The increase in the percentage uncertainty of the volume measurement is the controlling factor in limiting the accuracy of the value of the function PV/T as the pressure increases.

These estimates of the accuracy uncertainty of functions, for example, compressibility factors, do not take into consideration the errors that may accumulate in mixing the sample or analyzing the constituent materials for the mixed sample. However, such sources of error are not significant in all possible applications of the measurements; for many engineering purposes it suffices that a difference in the values of a property of a system at two different states be susceptible to accurate measure although both the measurements of the property be subject to the same systematic error.

Compressibility of Natural Gas

The compressibility data determined on the natural gas by means of the equilibrium cell are illustrated in Figure 6. The cell was operated at the indicated temperatures, and volume measurements were made in pressure intervals not greater than 250 pounds per square inch to determine the shape of the curves. The volume measurements were made after the sample volumes became constant on stirring the sample in the cell with the pressure controlled to ± 0.1 pound per square inch and the temperature controlled to ± 0.1° F. Two gas samples of different masses were used in the cell in turn so that the experimental pressure range (500 to 5000 pounds per square inch) could be covered without the necessity of measuring a gas volume of less than 100 cc. There was considerable overlapping in the measurements of the two samples in the pressure range of 1500 to 3000 pounds per square inch.

The mass and the specific volume of the gas sample used in the cell were determined from the volume of the sample at a pressure of 1400 pounds per square inch absolute and a temperature of 130° F. The specific volume of the gas at that pressure and temperature was computed from the specific volume of the gas at 14.4 pounds per square inch absolute and 75° F. (21.200 cubic feet per pound) and the measured ratio of the gas volumes at the two pressure and temperature conditions (0.009760). The gas-weighing flasks and the method used for measuring the specific volume of the P-V-T gas at atmospheric pressure have been described.

The ratio of gas volumes (volume at 1400 pounds per square inch absolute and 130° F. divided by the volume at 14.4 psia. and 75° F.) was determined five times by expanding gas samples from the steel pycnometer into the 12-liter glass flask and twice by expanding samples from the equilibrium cell into the glass flask. The mean value of the seven measurements of the ratio was 0.009760 ± 0.000006. The average of the residuals obtained in the measurements was 0.000017. It was estimated that the mean value of the ratio was subject to a precision uncertainty of 0.06 percent. The product, $21.200 \times 0.009760 = 0.20691$ cubic feet per pound was the specific volume of the gas at 1400 pounds per square inch absolute and 130° F. and was estimated to be subject to a

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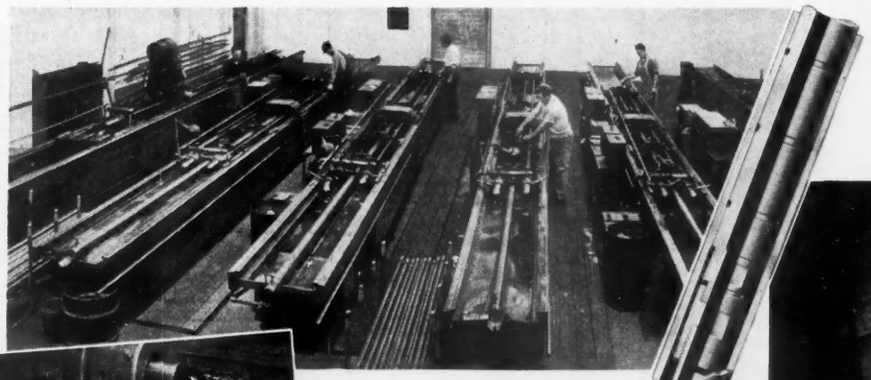

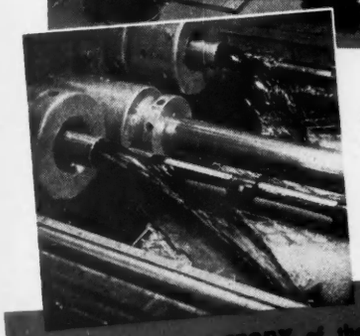

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precision uncertainty of less than 0.1 percent.

The specific volume measurements were made at regular pressure intervals, and the results were plotted as functions of both temperature and pressure to determine the shape and positions of the curves illustrated in Figure 6. It is estimated that the values of the function Pv/T represented by the curves and used to compute the values of v and Z shown in Table 2 are subject to a precision uncertainty of ± 0.03 percent.

The limit value of the function Pv/T was determined by extrapolating the isotherms illustrated in Figure 6 to zero pressure. The specific volume datum at 14.4 pounds per square inch absolute and 75° F. which was obtained by means of the glass weighing flasks, permitted locating accurately the focal point of the isotherms, which is the value of gas constant b. The value of the gas constant for the separator gas (b = 0.57233) is given at the bottom of Table 2.

Values of the function Pv/T, illustrated by the curves of Figure 6, at given pressures were divided by the value of gas constant b to provide the compressibility factors Z compiled in Table 2 and presented in Figure 7 as functions of the pressure, and in Figure 8 as functions of the temperature. Figure 7 is a method of illustration closely related to Figue 6, from which the data for the computations were obtained. Figure 8, involving more nearly linear functions, is better suited for engineering applications. The specific volumes given in Table 2 were computed by use of equation 1.

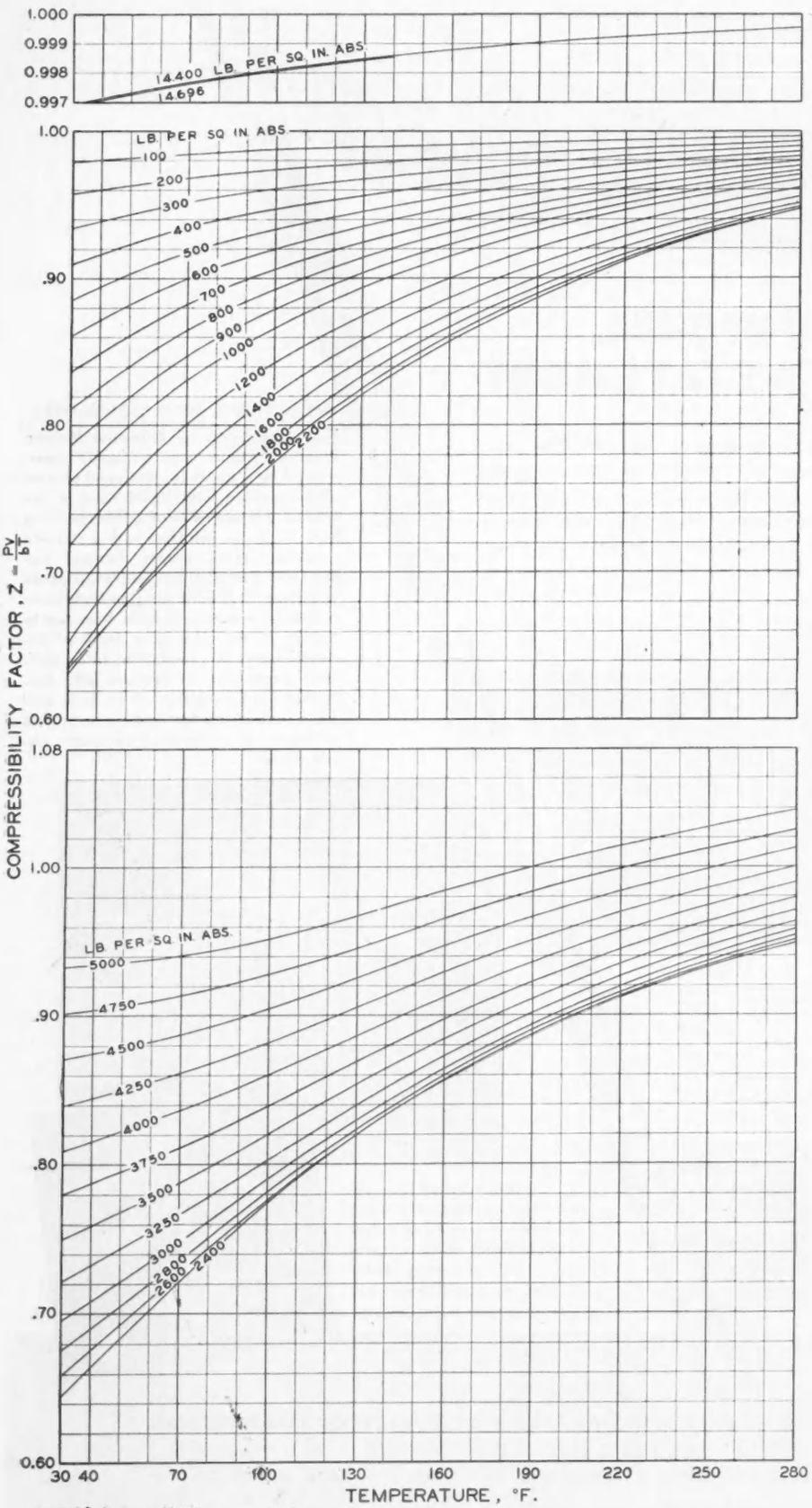

FIGURE 8. Isobars of compressibility factors for a tepetate separator gas.

P-V-T Relationship of Mixed Gases

When volumes of different gases at the same pressure and temperature are mixed, the volume of the mixture at that pressure and temperature does not necessarily equal the sum of the volumes of the constituent gases. Simple equations can be derived for describing the relation between the volumes of the constituent gases and the volume of their mixture, whether the total volume on mixing is additive or otherwise.

Equation 1, introduced in a preceding section of this report, was for one pound of gas. The general equation expressing the P-V-T relationship for any number of pounds or moles of a gas is,

$$\frac{PV}{ZT} = NR \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Concepts involved in gas measurement which are related to equation 2 and were not defined in the discussion of equation 1 are as follows:

N = number of pound moles of gas involved. For a gas of molecular weight M (pounds per mole), the mass of the gas being measured will be NM (pounds).

R = universal gas constant and has the value of 10.732 with engineering units. The gas constant b and the molecular weight M determined experimentally on any gas yield a product Mb which is substantially equal to the value of R the universal constant.

V = NMv = volume of N moles of gas of molecular weight M where each pound of the gas has a volume of v cubic feet. The units of the volume V are cubic feet.

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The quantity of a gas, whether it is a single component or a mixture of components, may be expressed conveniently by the terms of equation 1 when they are rearranged to show the moles of gas involved. Thus, if different gases identified by the subscripts 1,2, ... respectively are measured in separate vessels, but at the same pressure and temperature, to obtain their volumes V_1, V_2, ..., the quantities in pound-moles of each of the gases involved may be expressed by the equation,

$$\frac{PV_1}{Z_1TR} + \frac{PV_2}{Z_2TR} + \ldots = N_1 + N_2 + \ldots \quad - - - - - - - - 3$$

The sum of these volumes of the gases is defined as the additive volume by the equation,

$$V_a = V_1 + V_2 + \ldots\ldots \quad - - - - - 4$$

If the gases then are mixed in a common container and measured at the same pressure and temperature as before, the volume of the mixture usually will not be the same as the additive volume V_a but the number of moles of gas involved will be unchanged and the experimentally determined volume of the mixture V can be expressed in the equation,

$$N_1 + N_2 + \ldots = \frac{PV}{RZT} \quad - - - - - - 5$$

Compressibility factor Z is the factor determined experimentally on the mixture of gases. On comparing equations 3 and 5, it is evident that the sum of the left-hand members of equation 3 equals the right-hand member of equation 5.

It is an object of this report to show how volume V of a mixture of gases can be computed from the additive volume V_a without resorting to expensive and time-consuming experimentation. The relation between the two volumes is expressed by the equation,

$$V_a W = V \quad - - - - - - - - - - - 6$$

where W, the additive volume correction factor, is a variable that depends for its value on the pressure, the temperature and the composition of the mixture of gases. In this study dealing with natural gas and nitrogen, the concentration of nitrogen in the nitrogen and natural-gas mixtures is the sole concept of the composition effects considered in evaluating the factor W.

In engineering computations, it frequently is more convenient to deal with compressibility factors than with volumes. It is important, therefore, to know the relation between the compressibility factors of the separate gases at a given pressure and temperature and the compressibility factor of the mixture of those gases at the same pressure and temperature. For the development of this relationship, the additive compressibility factor Z_a is defined by the equation,

$$Z_a = \frac{N_1Z_1 + N_2Z_2 + \ldots\ldots}{N_1 + N_2 + \ldots\ldots} \quad - - - 7$$

From equation 4, if volumes V_1, V_2, ... of the separate gases are expressed in the terms shown in equation 2, there is obtained the relation,

$$V_a = V_1 + V_2 + \ldots = \frac{RT}{P}(N_1Z_1 + N_2Z_2 + \ldots) \quad - - - 8$$

When the additive compressibility factor Z_a defined by equation 7 is introduced into equation 8 there is obtained the relation,

$$V_a = \frac{RTZ_a}{P}(N_1 + N_2 + \ldots) \quad - - - 9$$

When equations 5 and 6 are combined to eliminate the term V the additive volume is expressed by another equation,

$$V_a = \frac{RTZ}{PW}(N_1 + N_2 + \ldots) \quad - - - 10$$

By eliminating the additive volume V_a between equations 9 and 10 and canceling common terms, the relation between additive compressibility factor Z_a and compressibility factor Z that would be measured experimentally for the mixture of gases, there is obtained the relation,

$$Z_a W = Z \quad - - - - - - - - - - - 11$$

A comparison of equations 6 and 11 reveals that additive volume correction factor W relates the compressibility factors in the same way that it relates the additive volume of separate gases and the actual volume of the mixture of those gases.

TABLE 2

Properties of a Tepetate separator gas

Pressure Lb. Per Sq. In. Abs.	SPECIFIC VOLUMES (V, CU. FT. PER LB.) AND COMPRESSIBILITY FACTORS (Z) AT INDICATED TEMPERATURE																	
	32° F.		70° F.		100° F.		130° F.		160° F.		190° F.		220° F.		250° F.		280° F.	
	v	Z	v	Z	v	Z	v	Z	v	Z	v	Z	v	Z	v	Z	v	Z
5000	0.05252	0.9333	0.05700	0.9403	0.06096	0.9516	0.06527	0.9672	0.06983	0.9846	0.07440	1.0005	0.07894	1.0147	0.08339	1.0266	0.08791	1.0384
4750	.05344	.9022	.05830	.9136	.06258	.9281	.06720	.9460	.07208	.9655	.07695	.9831	.08179	.9989	.08655	1.0123	.09135	1.0251
4500	.05447	.8711	.05977	.8874	.06438	.9046	.06939	.9254	.07462	.9469	.07983	.9662	.08501	.9835	.09008	.9981	.09521	1.0122
4250	.05565	.8406	.06144	.8615	.06646	.8819	.07189	.9055	.07754	.9292	.08313	.9503	.08872	.9694	.09414	.9852	.09962	1.0002
4000	.05700	.8103	.06338	.8364	.06886	.8600	.07478	.8864	.08090	.9125	.08696	.9356	.09301	.9565	.09883	.9734	.10466	.9890
3750	.05862	.7813	.06557	.8113	.07168	.8393	.07818	.8689	.08487	.8975	.09146	.9225	.09798	.9447	.10428	.9629	.11050	.9789
3500	.06044	.7518	.06821	.7876	.07510	.8207	.08229	.8535	.08957	.8841	.09677	.9110	.10385	.9345	.11070	.9540	.11734	.9702
3250	.06269	.7241	.07149	.7665	.07920	.8036	.08721	.8399	.09522	.8727	.10314	.9016	.11083	.9261	.11828	.9466	.12544	.9631
3000	.06547	.6981	.07559	.7481	.08435	.7901	.09327	.8292	.10215	.8642	.11082	.8942	.11918	.9193	.12730	.9404	.13505	.9571
2800	.06821	.6788	.07964	.7357	.08942	.7818	.09919	.8231	.10884	.8594	.11821	.8903	.12712	.9151	.13584	.9365	.14416	.9536
2600	.07166	.6622	.08476	.7271	.09562	.7763	.10640	.8198	.11681	.8565	.12692	.8876	.13654	.9127	.14588	.9339	.15475	.9505
2400	.07607	.6489	.09111	.7214	.10330	.7741	.11516	.8190	.12645	.8558	.13734	.8866	.14778	.9119	.15780	.9325	.16724	.9482
2200	.08181	.6397	.09919	.7199	.11284	.7751	.12593	.8210	.13817	.8572	.14997	.8874	.16128	.9122	.17205	.9320	.18224	.9472
2000	.08960	.6369	.10980	.7245	.12498	.7805	.13932	.8258	.15267	.8610	.16542	.8899	.17765	.9135	.18943	.9329	.2005	.9472
1800	.10055	.6433	.12364	.7342	.14050	.7896	.15634	.8340	.17084	.8672	.18471	.8943	.19803	.9164	.2110	.9350	.2231	.9486
1600	.11593	.6593	.14233	.7513	.16101	.8044	.17821	.8450	.19405	.8755	.2093	.9009	.2240	.9215	.2383	.9386	.2517	.9516
1400	.13797	.6865	.16756	.7739	.18789	.8213	.2069	.8584	.2246	.8865	.2416	.9097	.2580	.9285	.2738	.9438	.2890	.9557
1200	.16964	.7235	.2024	.8012	.2248	.8424	.2461	.8751	.2660	.9003	.2853	.9208	.3038	.9372	.3217	.9507	.3391	.9612
1000	.2157	.7668	.2520	.8313	.2774	.8661	.3017	.8942	.3246	.9153	.3467	.9325	.3682	.9465	.3892	.9583	.4094	.9671
900	.2470	.7900	.2856	.8479	.3129	.8793	.3390	.9042	.3638	.9232	.3878	.9387	.4112	.9514	.4341	.9621	.4563	.9701
800	.2864	.8142	.3278	.8653	.3575	.8929	.3857	.9144	.4128	.9313	.4392	.9451	.4650	.9564	.4904	.9661	.5150	.9733
700	.3372	.8390	.3822	.8826	.4147	.9064	.4458	.9249	.4760	.9396	.5054	.9517	.5344	.9618	.5628	.9701	.5906	.9766
600	.4048	.8632	.4549	.9006	.4910	.9199	.5260	.9353	.5602	.9480	.5939	.9585	.6269	.9671	.6594	.9741	.6913	.9799
500	.4993	.8874	.5565	.9181	.5980	.9336	.6383	.9458	.6782	.9563	.7178	.9653	.7565	.9725	.7947	.9784	.8324	.9832
400	.6409	.9112	.7087	.9353	.7585	.9473	.8069	.9565	.8553	.9647	.9035	.9721	.9509	.9779	.9977	.9826	1.0438	.9864
300	.8770	.9351	.9621	.9522	1.0259	.9610	1.0882	.9675	1.1507	.9734	1.2131	.9789	1.2749	.9833	1.3359	.9868	1.3964	.9897
200	1.3478	.9580	1.4681	.9687	1.5603	.9744	1.6509	.9784	1.7418	.9823	1.8326	.9858	1.9231	.9889	2.0128	.9912	2.1020	.9932
100	2.7561	.9796	2.9849	.9848	3.1626	.9875	3.3378	.9891	3.5150	.9912	3.6914	.9929	3.8678	.9944	4.0437	.9957	4.2184	.9966
14.4	19.48	.9970	21.00	.9977	22.20	.9981	23.40	.9985	24.60	.9988	25.79	.9990	26.99	.9992	28.19	.9994	29.38	.9996

Note: Value of gas constant for 1.0 pound of gas is $b = \frac{Pv}{ZT} = 0.57233$ $\frac{\text{lb. sq. in abs. x cu. ft. per lb.}}{\text{°F. abs.}}$

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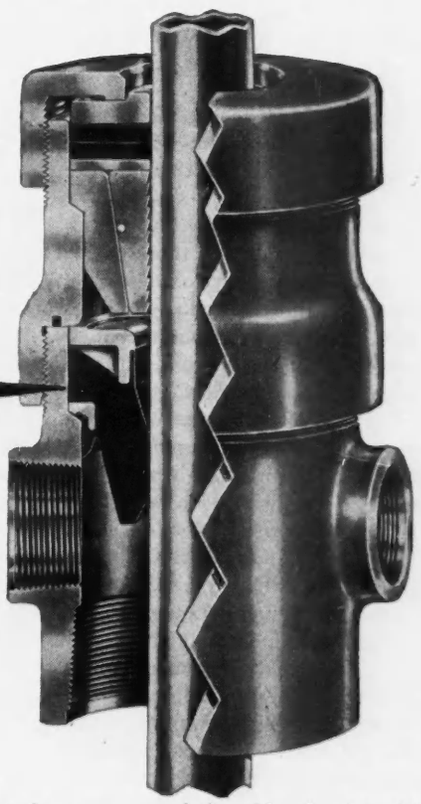

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Effect on Production of Fluid Distribution and Relative Permeability In Sand

By HARRY M. RYDER

DIFFERENTIATING between oil-wet and water-wet sands, and illustrating the mechanics of augmented production through various types of drive, the author offers suggestions as to how much presently "lost" oil may be recovered from various formations through study and application of the principles advanced.

ONE basic problem facing all oil producers is that of determining the procedure necessary to produce ultimately the most oil, consistent with a satisfactory profit, from a given property and within desired production-rate or time limits. The greatest ultimate oil production regardless of cost and time considerations is not the problem; rather a nice balance between quantity produced and the economic and strategic factors concerned. For an oil producer to know that he is operating his property so as to achieve the desired objectives, he must have the benefit of a knowledge of the conditions necessary for optimum oil recovery at minimum cost from that particular property. So far as the reservoir is concerned, such knowledge can be gained only from an understanding of how gas, oil and water are held in, move, and are moved through oil sand pores under his field conditions.

In most oil sands, oil, gas and water are present. Most operating oil wells produce at least two of these fluids simultaneously; many wells produce all three at the same time. Much has been published on the effect of various operating procedures on the quantity of oil ultimately produced from a property and on the ultimate profit from that operation. Not all pronouncements are in agreement. It is generally agreed that the maintenance of a high level of reservoir energy available for the movement of fluids will result in a greater quantity of oil ultimately produced than if the energy level be low. But there is no general agreement on the effect of the rate of oil production or of various other factors on the quantity of oil ultimately produced. It is the purpose here to examine the problems of removing oil from sand when that oil shares the pore space with other fluids.

Oil is pushed, pulled or dragged from a position in a pore by water, gas, capillary forces, or gravity. This is the fundamental operation in all oil recovery. It is estimated that the production of a single barrel of oil from Bradford sand requires the removal of the available oil from more than 5 billion feet of pores. For this reason, an exceedingly slight increase in the quantity of oil removed from each very short pore is multiplied enormously in the tank. The fundamental problem of the oil producer is therefore that of how most profitably to remove the most oil from each single microscopic pore.

In solving the problem it is first necessary to understand:

(1) The nature and relative magnitude of the forces tending to hold the oil in the pore.

(2) The effects and relative magnitude of the forces available to move oil from the pore and the means by which oil is moved.

(3) The effects of pore structure, of the nature of pore surfaces, of the contents of the pores and of the arrangement of those contents on the ability of applied forces to reach each oil-occupied pore and to remove oil from it.

To arrive at an understanding of these matters, it is necessary to have an adequate knowledge of:

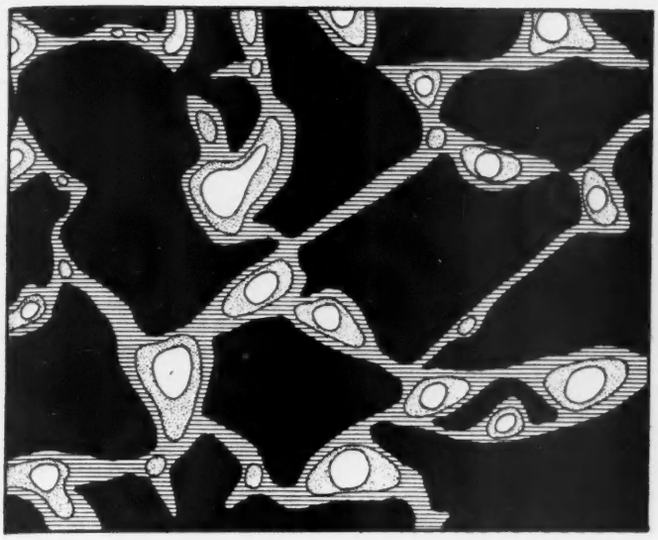
(1) The sizes and shapes of pores.

(2) The nature of pore surfaces.

(3) The positions within the pores of the contained fluids.

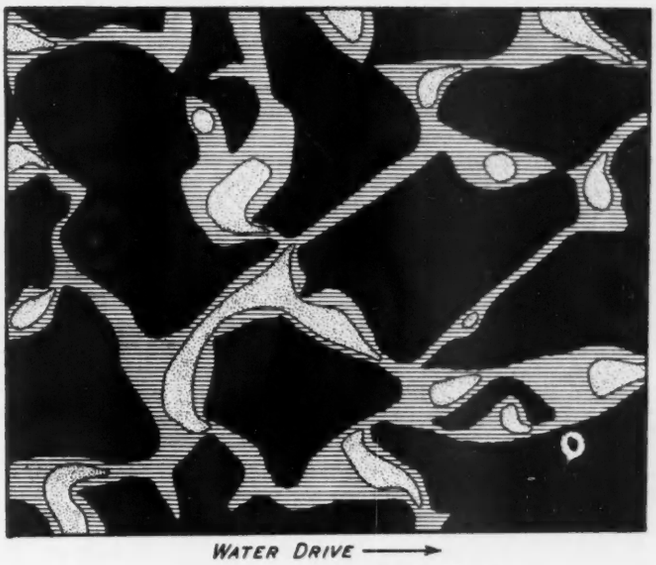
The first two of these requirements have been discussed in previous articles of this series.[1,2] As to the third requirement, the literature reveals no observation of the positions of fluids within the pores in natural oil sand. It is probable that such observations cannot be made in natural materials. Some years ago S. T. Yuster[3] prepared a very thin permeable body by sintering crushed glass between glass plates the size of a microscope slide. Observations under the microscope were made of fluid positions and movements. However, some of the conditions were quite different from those existing in oil sands and Yuster never reported formally his observations.

A knowledge of the position of oil, water and gas within a pore is necessary to an understanding of the mechanics of the removal of oil from that pore. Since that knowledge cannot be gained by direct observation, deduction from laboratory work, field experience, and knowledge of the fundamental behavior of fluids must be resorted to. Such procedure, common in scientific investigation, is subject to verification and has proved invaluable. No one has ever seen a light wave or a radio wave



SOLIDS
CONNATE WATER
OIL
GAS

FIGURE 1
VENANGO SAND
AFTER GAS EXPANSION
NO FLOW—VERY LOW PRESSURE
OIL SATURATION—30% TO 35%
WATER—MORE THAN 35%
SAND IS WATER-WET



WATER DRIVE ⟶

SOLIDS
MIXED WATER
OIL
ALL GAS DISSOLVED

FIGURE 2
VENANGO SAND
MODERATE PRESSURE
MODERATE PRESSURE GRADIENT
WATER FLOWS AROUND OIL GLOBULES
ESSENTIALLY NO OIL PRODUCTION

or electricity, but deductions from observations concerning these phenomena have provided the basis of outstanding progress. The following discussion and conclusions result from similar deduction.

The Mechanics of Oil Removal

Figure 1 is a sketch of part of a greatly magnified thin section of Venango, Pa., sand, copied from a photomicrograph made by Honess.[4] The solids in the sand are represented by solid black, the remainder being pores. Within the pores has been sketched a probable arrangement (as to character, not detail) of the positions of the oil, water, and gas as of the time of depletion by gas expansion, with no fluid movement and with very little static pressure. Undisclosed irregularities in the third dimension have been considered absent for the purpose of this and the other figures. The fluid arrangement is based on the following facts:

(1) The pores are of capillary dimensions.

(2) The pore walls are water-wet.[1,5]

(3) Many tests of fluid contents of Venango oil sand.

(4) The classic concepts of capillarity and interfacial forces.

(5) No prior natural or artificial water drive.

(6) There has been a rest period since the last previous fluid movement other than capillary adjustment.

Under these conditions, the water is in contact with all pore surfaces, the free gas is in the form of bubbles, mostly confined to the enlargements in the pores, and the oil is in the form of films surrounding the gas bubbles.

Figure 2 represents the same sand and the same conditions except that water, naturally or artificially driven, is moving from left to right under pressure through the sand. The pressure has caused the solution of the free gas in the oil. In pores through which water is flowing, the oil has been dragged and pushed in the direction of flow toward the nearest down-stream constriction in the pore. Because of the low oil saturation (30 to 35 percent) and the high oil-water interfacial tension, the moving force is less than the counter forces and the oil does not move through the constriction. The water moves around the oil and through the constriction without moving the oil with it. This is in accord with the results of the various unsuccessful attempts which have been made to produce oil from the Venango sand by water flooding. Had the oil saturation been very much higher, the flowing water would have moved oil through to a producing well. (See Figure 7 of reference 5.) But under the circumstances of Figure 2, the only effect of the oil is to partially plug the pores at the constrictions, thereby reducing the rate of flow of water through the sand below the rate that would have prevailed had no oil been present. This condition, too, is evident in Figure 7 of reference 5.

Figure 3 represents the same sand and the same conditions as in Figure 1 except that gas under pressure is driving through the sand from left to right. Gas has passed through the pore in the upper left. Gas fronts are present in the lower center and upper right. The gas has driven out some water and again has driven oil down stream to constrictions. But now surface tension and interfacial tension prevent gas from by-passing the oil at the constrictions. Hence the force developed by the gas pressure increases until it overcomes the counter forces of the oil-water interfacial tension and oil is driven through the constriction. In this manner oil, unless trapped in some side pocket, is driven on to a producing well. The oil remaining in side pockets, in films on water surfaces, and in unaffected pores constitutes the unproduced "residual oil saturation." This is in accordance with the experiences of many gas- and air-repressuring projects in the Venango sand.

Figure 4 is representative of very different circumstances. It is a sketch of a part of a greatly magnified thin section of Bradford, Penn., oil sand, also copied from a photomicrograph made by Honess.[4] Again, within the pores has been sketched a probable arrangement (as to character, not detail) of the oil, water and gas as of the time of depletion by gas expansion, with no fluid movement and with very little static pressure. The fluid arrangement is based on the following facts:

(1) The pores are of capillary dimensions.

(2) Most of the pore surfaces are coated with organic material and are preferentially oil-wet.[3,5]

(3) With oil and water both in nearby contact with the sand, the presence of that water strongly increases the oil-adsorption forces.[3,6]

(4) Many tests of the fluid contents of Bradford sand.

(5) The classic concepts of capillarity.

(6) The very high salinity of the connate water, indicating extensive evaporation of water prior to the entry of oil into the sand.

Under these circumstances, the small quantity of residual connate water would necessarily be located in blind pockets and the smallest pores prior to the entry of oil. At that time there would remain on the exposed pore surfaces only an adsorbed film of water molecules in equilibrium with the atmosphere in the pores. Upon the subsequent entry of oil, that oil came in virtual contact with much of the pore surface, in time permitting the selective adsorption of certain petroleum molecules directly on the pore surfaces. Thus could have been formed the observed coating of organic material.

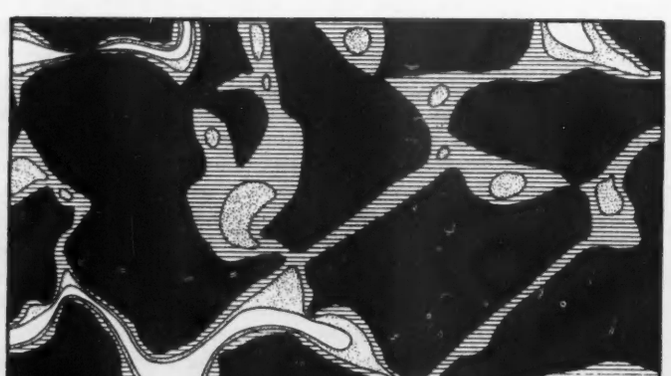
A result of the higher oil saturation, of the lower water saturation, and especially of the oil-wet pore surfaces is a completely different fluid distribution arrangement from that in the Venango sand. As in the Venango sand, connate water in the Bradford sand occupies side pockets and some of the smaller pores. But with that, the resemblance ceases. Elsewhere oil is in contact with and covers the pore surfaces, fills many of the smaller pores, and, in the larger pores, encloses gas bubbles to the pore walls.

Figure 5 represents the same Bradford sand and the same conditions as in Figure 4 except that water, naturally or artificially driven, is moving rapidly from left to right under high pressure and with a high pressure gradient. Again, pressure has caused the solution of the free gas in the oil. But, because the oil is in contact with the pore walls, water cannot move around that oil. The pore walls are hydrophobic. The water must therefore move through the oil. To do so, it must and does push oil forward to provide space for the water. The strong pressure in driving the water forward works to make the cross-sectional area of the water moving within the pore as large as possible, for even the largest pores in the sand are of capillary dimensions. Opposing this, adsorption forces, greatly increased by the effect of the nearby water-solids contact, work to maintain as thick an oil film as possible over the preferentially oil-wet surfaces.

The adsorption forces are fixed. The very high pressure gradient and the relatively very high velocity of the moving water provide a maximum of energy available for moving oil, by pushing and dragging, away from the influence of the adsorption forces toward a producing well. Necessarily the result is a residual oil film of minimum thickness remaining on the pore surfaces, a minimum of unrecoverable oil held in this manner. The fluid-distribution pattern of Figure 5 results.

Figure 6 again represents the same Bradford sand and the same conditions as in Figure 4 except that water, naturally or artificially driven, is moving very slowly from left to right under very low pressure and with a very low pressure gradient. In the unflooded part of the sand not all free gas has been forced into solution in the oil. As in Figure 5, oil is in contact with pore surfaces. And, as in the case of the rapid drive, the water necessarily moves through the oil, driving oil ahead of it to provide space for the water. Some of the driven oil may move to a producing well, some occupies space previously occupied by free gas. But in this case the pressure is low and the velocity of the water is low. Therefore, the energy available for removing oil from the influence of the fixed adsorption forces is low. The result is thicker films of residual oil on the pore surfaces, less oil moved away from the pore surfaces, and more unrecoverable oil held within the water-containing pores.

The actual dimensional difference is



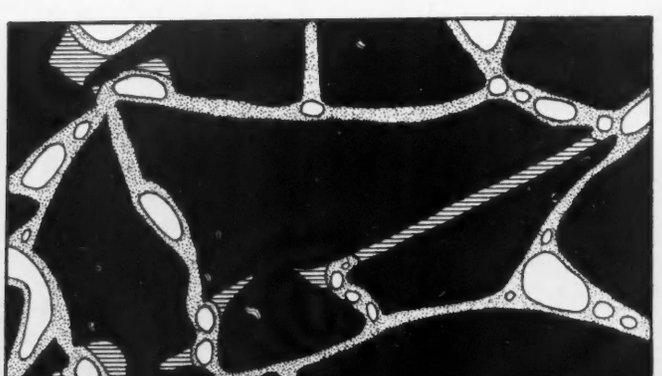
GAS DRIVE →

SOLIDS
MIXED WATER
OIL
DRIVING GAS

FIGURE 3

VENANGO SAND

MODERATE PRESSURE
MODERATE PRESSURE GRADIENT
GAS, OIL, AND WATER FLOW
PEAR-SHAPED OIL GLOBULES IN MOTION
OIL BEING PRODUCED



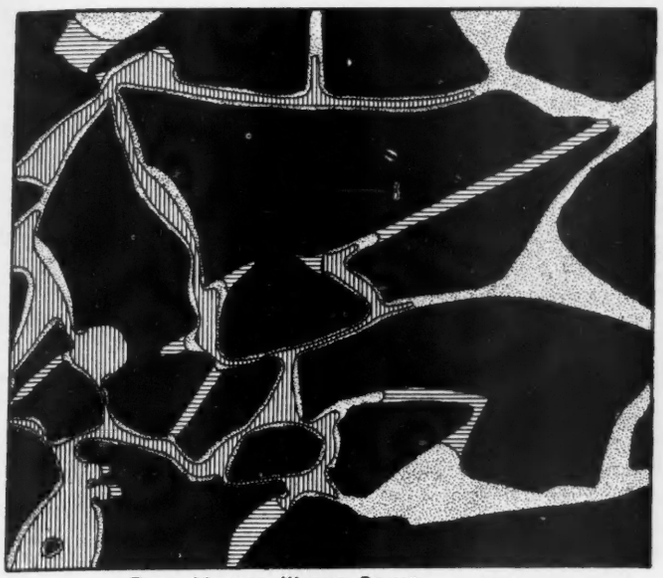
SOLIDS
CONNATE WATER
OIL
GAS

FIGURE 4

BRADFORD SAND

AFTER GAS EXPANSION
NO FLOW—VERY LOW PRESSURE
OIL SATURATION 45%
WATER 15%

SAND IS OIL-WET OPPOSITE OIL ONLY



FAST MOVING WATER DRIVE ⟶

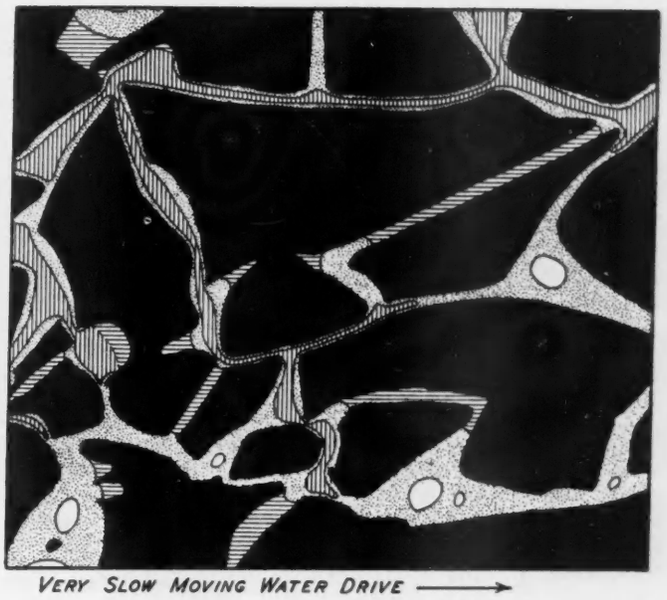
SOLIDS
CONNATE WATER
DRIVE WATER
OIL
ALL GAS DISSOLVED

FIGURE 5

BRADFORD SAND

HIGH PRESSURE WATER DRIVE
HIGH PRESSURE GRADIENT
HIGH VELOCITY
LOW RESIDUAL OIL SATURATION

WATER-DRIVE FRONT NEAR CENTER



VERY SLOW MOVING WATER DRIVE ⟶

SOLIDS
CONNATE WATER
DRIVE WATER
OIL
GAS

FIGURE 6

BRADFORD SAND

VERY LOW PRESSURE WATER DRIVE
VERY LOW PRESSURE GRADIENT
VERY LOW VELOCITY
HIGH RESIDUAL OIL SATURATION

WATER-DRIVE FRONT NEAR LOWER CENTER AND BEYOND TOP RIGHT

very slight between a "thick" and a "thin" film of adsorbed oil. It is estimated that in ordinary efficient water-drive oil-production operations in the Bradford field, the reduction in the thickness of the oil on the pore surface is of the order of 0.00002 millimeters (0.000001 inch) or less. A further reduction of only 0.000002 mm (0.0000001 inch), resulting from the use of higher pressure gradients and higher velocities, would mean an increase of 10 percent in tank oil. Physically it is possible to reduce the oil-film thickness to this extent and more. But such reduction has not yet been measured. A carefully arranged laboratory investigation is needed to determine the values of and the relation between adsorption forces, applied forces and resultant oil-film thickness.

But a thicker oil film is not the only adverse effect of the low-energy water drive. As the head of a water column moves into an oil-filled constriction, more and more pressure is required to drive it through against the forces set up by the oil-water interfacial tension and adsorption. Normally, the head of the water column will hesitate at this point, awaiting the necessary pressure buildup. In the meantime, water is moving forward nearby through a larger and more favorable by-passing pore. The pressure on the water-column head, waiting at the constriction, depends on the back pressure of the nearby moving column of water. If that column of water is moving very slowly, the back pressure will build up very slowly and the water-column head at the constriction will continue to stand motionless.

If, in the meantime, the moving by-passing column of water re-enters, farther on, the pore containing the waiting column of water, an encirclement of oil is completed, and oil is trapped. This situation is represented in the lower left of Figure 6. At two points near the left side, water is awaiting sufficient pressure to move through the constrictions. In the meantime, slow-moving water is able to take the course indicated just above on the left side, completes the encirclement and traps oil in the lower left of the Figure. Pending other treatment, all the oil represented in the lower left of Figure 6 is trapped, becomes part of the "residual oil saturation" and is lost to production.

In the case of the high-pressure-gradient, high-velocity water drive indicated in Figure 5 the back pressure developed in the by-passing column of water caused a pressure buildup at the water-column heads (hesitating at the constrictions) sufficient to force the water through the constrictions. After that they move forward rapidly, driving oil out before the trap could close.

Under low-pressure-gradient, low-velocity conditions, because the pore surfaces are oil-wet, capillary forces are unable to aid the low pressure gradient in moving water. On the contrary, the capillary forces oppose the movement of the water and can be overcome only by a sufficient pressure gradient. In this manner and otherwise, the very-slow-moving water drive moves only a small part of the contained oil from sand whose surfaces are oil-wet.

Many analyses of field experience[7,8] have shown beyond peradventure that high-pressure-gradient high-velocity water drives in the oil-wet natural sand of the Bradford field result in a lower residual oil saturation than do low-pressure-gradient, low-velocity water drives through that same sand under otherwise identical conditions. Illuminating test data are available from many Bradford wells drilled into areas of almost all possible variations of known previous water-drive activity. The critical study of the relation of oil and water saturation and permeability to previous water-flood activity and subsequent production experience in Bradford sand very strongly support the above conclusion.

For instance, southward of Rixford, in the Bradford field, there is present a large, relatively very uniform area of some of the best oil sand in the field. In some parts of this area numerous

abandoned wells leaked, causing the exceedingly slow permeation of water into the nearby sand. The oil recovery from such sand has been uniformly very poor. Numerous core tests from that "water-soaked" sand show not only very high total-liquid saturation, but also very high oil saturation, in most cases more than 60 percent of the pore space filled with oil. And yet essentially only water comes from that sand. In numerous cases a drilling well was essentially dry until that "water-soaked" sand was encountered. As soon as that sand was drilled, water would rise hundreds of feet in the hole, water from that high-oil-content sand which, however, brought practically no oil with it.

But upon drilling that same formation in areas just beyond the limits of water permeation, in sand no richer in oil but with only the normal water content, a large volume of oil with no water would enter the drilling well. Students of the Bradford sand have learned to recognize "water-soaked," high-oil-content sand for what it is: sand most of whose oil content at present is unavailable. Literally hundreds of similar cases have been recognized in the Bradford field. In some cases the source of the very-slow-moving water has been old wells, but the very slow movement of encroaching water into the southwest part of the field, especially in the neighborhood of Marshburg, has immobilized very large quantities of oil.

That oil production from certain sands elsewhere reacts similarly to natural or artificial water-drive pressure gradient and velocity is suggested by the literature. By the standards used here, the natural water drive in the Woodbine sand in the East Texas field is rapid. Available reports indicate a very low oil saturation in that Woodbine sand through which the driving water has moved rapidly. On the other hand, reports indicate that in the Oklahoma City Wilcox sand the encroachment water moved very slowly by any standard. Katz[9] reported very high oil content in that sand through which the encroachment water actually passed. Perhaps these examples constitute coincidences. But if the East Texas Woodbine and the Oklahoma City Wilcox oil sands are in fact oil-wet, as the Bradford and Burkburnett sands are known to be, there is a strong possibility that an inverse relation between pressure gradient and residual oil content is present here too.

From the foregoing, so far as the effectiveness of oil-driving mediums is concerned, two classes of oil sands suggest themselves: sands with water-wet pore surfaces and sands with predominantly oil-wet pore surfaces. In the former, water driving is likely to be technically (not necessarily economically) inefficient or, as in the case of the Venango sand, economically impossible. In oil-wet sand, water driving may be efficient or otherwise, depending on the manner in which that drive is conducted. Formations with very high permeability barren beds, crevices, or other major bypassing means constitute another problem not here concerned. The matter of forming areally very large traps in sand without the benefit of such means is also beyond the scope of this article.

Effective Permeability Considerations

The predetermination of the volume and pressure of naturally or artificially supplied water or gas necessary to drive oil from a sand most effectively requires some knowledge of the effective permeability of the sand concerned under the conditions present or to be imposed. A knowledge of the measured permeability is necessary, but is not sufficient.

Calculations from permeability measurements may indicate that at a given pressure 100 barrels of water may be forced into a given well. If that were a normal Bradford well, after the first few months it would actually take only about 11 barrels of water daily at that pressure. In that case, the effective permeability under the specific conditions would be hardly more than 10 percent of that measured. The sand under those conditions would have a relative permeability of about 11 percent. If the measured permeability of the sand at that well were ten millidarcys, the effective permeability would be only 1.1 millidarcys.

The effective permeability controls the rate of flow of the fluids through the sand under the specified conditions. When two or more immiscible fluids are present in the sand, the effective permeability is always lower than the absolute permeability, in most cases very much lower. Effective permeability is an elusive quantity. Henderson and Yuster,[5] in their Figures 5, 6 and 7, present relative permeability curves for four different sands (one of them at two different pressures) from data obtained under otherwise comparable conditions. From that report, Table 1 has been prepared.

TABLE 1
Permeability in Millidarcys

CORE	EFFECTIVE TO OIL AT			Ratio 40 Percent to 30 Percent
	Absolute	30 Percent Oil Sat.	40 Percent Oil Sat.	
Venango sand B-4-A	148	0.67	27.1	40.5
Bradford sand 27-BT-3	83	1.2	5.8	4.83
Bradford sand 27-BT-3, acidized	105	2.0	5.3	2.65
Bradford sand 9-KS-1, 21 psi	105	0.65	4.9	7.55
Bradford sand 9-KS-1, 42 psi	105	2.2	6.9	3.13

These measurements were obtained during the enforced simultaneous flow of both oil and brine into and through the sand. Under the conditions of the measurements, the effective permeability of the Venango sand to oil at 40 percent oil saturation was more than 40 times that when the sand contained 30 percent oil; the oil-flow rate at the higher saturation would be more than 40 times that at the lower saturation. The corresponding effective permeability ratios for the Bradford sands range from 2.65 for the acid-treated sand to 7.55 for core 9-KS-1 at 21 psi. Merely raising the pressure and therefore the rate of flow through one of the Bradford sand cores more than tripled the effective permeability to oil; the actual rate of flow of oil was increased almost five times by doubling the pressure!

The effective permeability depends not only on the absolute permeability, the pressure gradient, and the quantities of each fluid present in the sand, but very importantly on the arrangements of those fluids within the sands. A study of the sketches above reveals why this is so. Unlike Henderson and Yuster's conditions, the sketches here represent the usual field procedure of a single driving fluid. Henderson and Yuster's findings are very revealing and are by far the most accurate so far made. They are very important to an understanding of effective permeability. But they are not directly applicable to the circumstances represented by the sketches in this article. Henderson and Yuster state: "Rather they (these results) serve to emphasize the importance of understanding the way in which the data are obtained."

The sand represented in Figure 2 holds 30 to 35 percent oil saturation. But with a water drive through that water-wet sand the effective permeability to oil is zero. The oil saturation in the sand of Figure 3 already has been reduced below that in Figure 2, but with a gas drive the effective permeability to oil, while low, is sufficient to provide a paying oil-production business for many operators.

It is outstanding in Table 1 that all of the effective permeability values are very low compared with the absolute permeability of the sand. In some cases the effective permeability is less than one percent of the absolute permeability. Any or all of the following conditions may serve to reduce the effective permeability of a sand when two or more immiscible fluids are present:

(1) An adsorbed immobile fluid film may "line" the pore, thereby reducing the part of the pore available for the flow of other fluids. (See the left sides of Figures 3, 5 and 6.)

(2) An immobilized droplet of one

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fluid may partially plug a constriction in a pore through which another fluid is moving. (See Figure 2.)

(3) Because of a too-low pressure gradient a column of fluid driving within another fluid may be unable to overcome adverse capillary forces. It is therefore unable to pass through a pore constriction. (See Figure 6.)

(4) One fluid may be surrounded and trapped by another fluid in one or a cluster of pores, thereby sealing those pores to further fluid movement. (See Figure 6.)

These conditions are very real and in many, perhaps most, cases dominate the pressure requirements for satisfactory fluid-flow rates. To illustrate, from Figure 5 of Henderson and Yuster,[5] at 40 percent oil saturation the effective permeability of the sand is seven percent of the absolute permeability. Under the conditions of those measurements the various effects listed above combined to cause a reduction of 93 percent in the rate of flow. At that effective permeability the pressure would have to be increased about 14 times to realize the rate of flow indicated by the absolute permeability. In normal Bradford sand water-flood operations the effective permeability is approximately 11 percent of the measured value. For a given production rate the pressure requirements are nine times the pressure which would be necessary if the effective permeability could be made equal to the absolute permeability.

The absolute permeability of a particular sand is fixed and (except by acidizing) cannot be changed. But the effective permeability is highly variable, the value depending in part on the conditions of operation. To the extent that the operator so handles his property as to improve the effective permeability of his oil-wet sand, he accomplishes one or more of the following:

(1) Increases the fluid production rate.

(2) Decreases power requirements, naturally or artificially applied.

(3) Reduces costs per unit of fluid produced.

At the same time realizes a greater ultimate oil recovery, getting more oil at lower cost!

How can this be accomplished? For the more usual reservoir conditions, field and laboratory experience combine to suggest the following:

(1) Water-wet sand with relatively low oil saturation. No water drive, natural or artificial, will be of much value. A gas drive is indicated.

(2) Water-wet sand with high oil saturation. If an abundant natural water drive is available it can be the means of a successful primary oil production. But the residual oil saturation will be high. To obtain more oil, a gas drive must be used. The most oil would be obtained if a gas drive were used from the beginning. But if an adequate natural water drive is available only local circumstances can determine the advisability of its use.

(3) Oil-wet sand of relatively low water saturation. By far the most profitable procedure from the standpoint of both effective permeability and ultimate oil recovery requires the use of a high-pressure-gradient, high-velocity water drive from the start of operations. Of course, very-high-permeability unproductive beds, open joints, crevices, etc., must be isolated or otherwise avoided. It should be superfluous to state that adequate lifting equipment must be provided, but the writer knows of cases in the Mid-Continent and in the East where rapid water drives were condemned when, in fact, the lifting equipment was not large enough for the job, a fact not realized by the operator.

Field experience with gas drives in sand of this character has proved them uneconomical. In two widely-separated areas in the Bradford field, each involving many wells, carefully engineered gas drives provided a peak oil production of less than one-half barrel of oil daily per well. Following a rest period of several years, water drives in the same sand resulted in a peak oil production of some 20 barrels of oil daily per well and an ultimate oil production several times as great as the gas drives could have provided in a twenty-year operation.

Of course, there are practical upper limits to pressure gradients and velocities. Sometimes these limits are imposed by the economics of equipment, sometimes by the maximum pressure that can be contained in the sand. Experience shows that a good objective is a linear velocity in the sand of from three to 12 inches per day in each sand layer being produced. This may be very different from an average of that rate. In most properties relatively low-permeability and high-permeability sand layers necessarily must be operated at the same pressure. Flow-rate-equalizing treatment such as selective shooting should be employed where practicable. But in every case, good engineering judgment must be relied upon to determine the strategically best rate and pressure.

In a water drive in a water-wet sand, capillary forces aid most in maintaining a regular front for the driving water if the pressure gradient and flow rate are low. On the contrary, in a water drive in an oil-wet sand, capillary and interfacial forces aid most in maintaining the most nearly regular front if a high pressure gradient and a high flow rate are maintained.

There are circumstances in which economic, legal, market or other strategic limitations make rapid oil-production rates inadvisable even though indicated to be important from reservoir considerations. In certain cases the best compromise would result from a series of cycles, each consisting of a period of rapid oil production followed by a rest period during which pressure would be maintained but only water removed from the producing wells. But compromises of this sort are far from fool-proof and must be carefully tailored to the circumstances. There is a best mode of operation for each property, the resort to which will result in the greatest practicable oil production at the lowest cost. But there is no one best procedure for all circumstances. Individual engineering is essential.

(4) Oil-wet sand with high water and high oil saturation ("water-soaked sand"). In this circumstance a water drive usually results in very little oil production. To the writer's knowledge, no field attempt to produce oil from a sand in this condition has proved successful. The reason can be understood from a study of Figure 6. Some of the oil is held under water in the form of relatively thick films on the pore walls. More oil is trapped by water. New water, in moving through the sand, merely moves around the oil. If the oil is to be recovered, it is necessary to release it from its containing water. To some degree this should be possible by driving gas, probably under high pressure, through the sand for a time and until the excess water is cleared. During this period both water and oil will be produced. By the time the water production has become small, most of the water-bound oil should be released. A new, rapid water drive should then be able to move much of the oil to production. But only competent laboratory and field tests can prove this suggested method. So far, this has not been done. By present methods, the very large volumes of oil in this category (millions of barrels in the Bradford field alone) cannot be produced.

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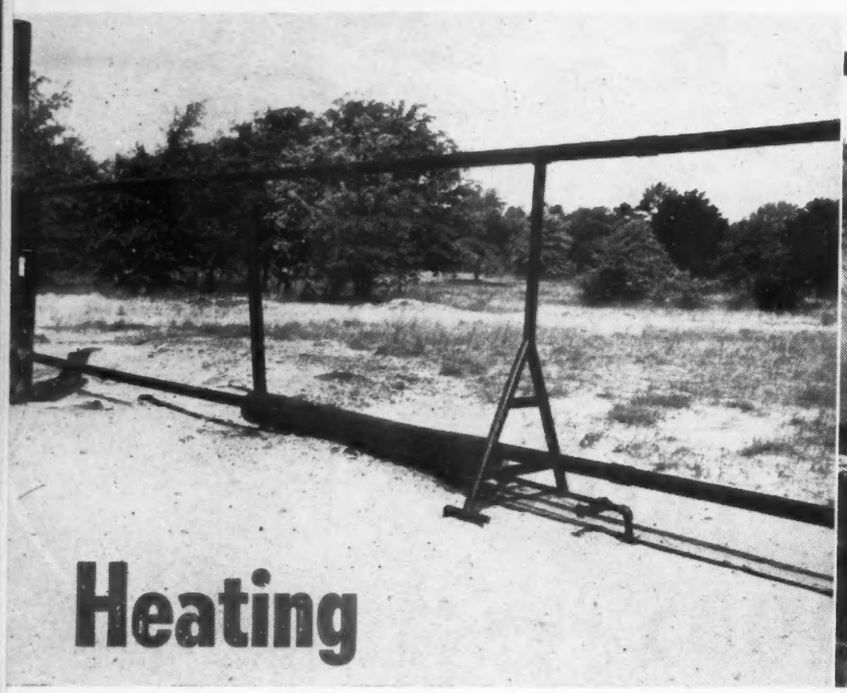

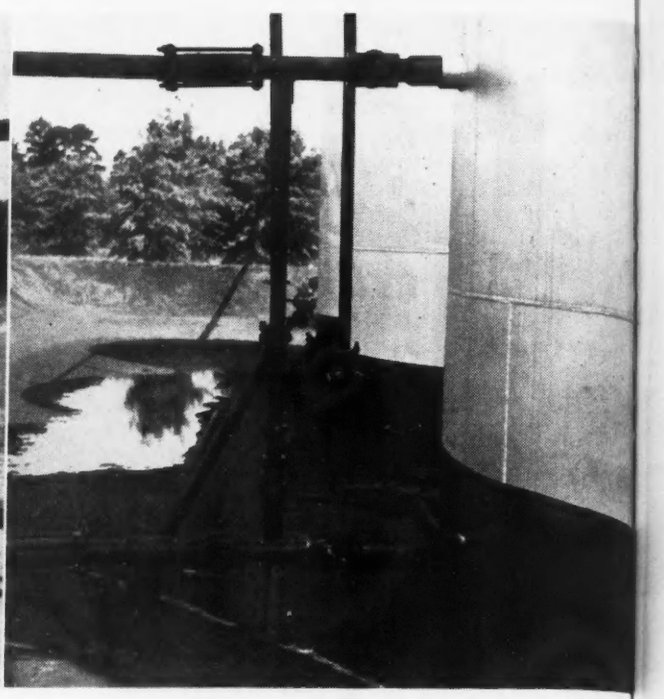

Heating

Reduces Tank Bottom Reconditioning

By M. H. PEARCE

THERMO-SYPHON flow through auxiliary heaters has been found effective in breaking up paraffin deposits and preventing sludge formation in certain types of paraffin-base crudes. Installation of equipment and added piping to facilitate this heating regardless of production flow helps maintain high pipe line quality fluid and reduces frequency of tank-cleaning operations.

MANY of the fields in the border counties of East Texas produce a paraffin-base crude which in addition to presenting paraffin troubles during producing the crude, carry a readily broken oil-water emulsion. This emulsion tends to revert in the tanks and form a sludge which seriously affects the pipeline quality of the oil. This sludge traps paraffin particles dispersed through the oil, and adds this material to the tank bottoms, forming a matrix on which still more paraffin tends to collect.

Treatment of the crudes is primarily one of heating them properly as they are produced, and in the application of heat to the tank bottoms and recirculation through the gunbarrel before the objectionable formation can collect in the field tanks. Paraffin-breaking chemicals, added to the flow from the heater or added to the fluid in the gunbarrel, also aid in combatting the trouble.

Tank batteries are equipped with an extra connecting line joining the bottom drain lines, and this in turn is tied in to a simple type of heater so that any tank bottom can be heated regardless of flow through the main production system. Thermo-syphon drive is relied upon to furnish circulation through the heater. Thus the cold or return line must be kept relatively clear of sludge or it will "freeze up" during down periods. Once flow is blocked through the heater system, the thermo-syphon flow can no longer cool the heater, and it soon is burnt up or carboned so badly as to be ineffective.

One operator prevents the blocking of the horizontal or cold return line by equipping it with a secondary heater. This unit is placed over the line at a point about three-fifths of the distance from the tank. This setting was determined after checking lines to find how far the heat from the relatively large body of fluid affected the temperature and thus the fluidity of the liquid in the pipe. The final setting of the auxiliary heater was at a point where heat from the gas-fired heater failed to travel through the thin-walled conductor (the pipe) and where the tank heating effect was lost. The heater, a simple pipe chamber surrounding the flow line and

FIGURE 1. (Top left) The auxiliary heater, placed over the section where tank heat and radiation from the vertical heater are least, enables the operator to warm up the fluid in the cold return leg and thus speed the flow of fluid from tank bottom to the emulsion breaker. Fired from the same gas line which supplies the main heater, the auxiliary unit may be cut off once desired flow rate is attained, thus reducing heating costs.

FIGURE 2. (Top right) This vertical bypass ties together the flow lines to and from the heater, and permits the flow through the lines to be short-circuited by closing the two tank valves and opening the one in the leg. Thermo-syphon flow through the pipe quickly brings the fluid in the lines to a temperature where viscosity loss is minimized, speeding active operation on the tank contents and preventing burning of charring of fluid in heater body.

gas fired so that flame travel would parallel oil flow, is fired only until thermo-syphon circulation is established, as determined by checking temperatures of the elevated and inclined return lines.

Bypass Speeds Heating Cycle

During the colder months chilling of the line seriously retards flow of the heated emulsion after it leaves the heating unit. A bypass, tying together the flow and return line near their points of attachment to the tank or gunbarrel and with block valves in the two lines between bypass and tank, enables the flow and return lines to be tied together and effective and fairly rapid circulation set up through them by firing the heater. The fluid in the loop will pass through the riser, giving up part of its heat while so doing, enter the bypass line, and return to the heater through the horizontal line, heating it until a balance is struck between the oil-borne heat and radiation to the surrounding air.

When the bypass fluid is thoroughly warmed, the two valves connecting the heating loop to the tank are opened and the valve in the bypass is closed. Flow then begins through the tank and the relatively sluggish tank bottoms are rapidly picked up and carried toward the heater. The bypass is located close to the tank wall, so that heat from the circulating fluid will break down any plug or clogging block which may have formed in the fitting restrictions in case of a long shutdown and consequent chilled fluid within the tanks. Expansion joints in both runs near the bypass absorb changes in line length as the pipe and contents warm up.

Various types of heaters are used for treating the tank bottoms. One which has been found particularly effective is in the shape of a squared "U." Flow from the tank bottom is at one leg of the horizontal "U", around the gas-fired flue, and out the other end of the unit, where a riser ties into a steeply pitched return line.

Welding Fabricates Heater

The heater is fabricated by welding throughout. The unit shown carries a six-inch heating chamber within a ten-inch shell. After the lengths of pipe are cut, the center section of six-inch is welded within the corresponding portion of ten-inch pipe, short web braces being tack-welded between the two pipes to main concentricity. The two legs of six-inch are welded to the beveled ends of the central six-inch portion, and then the two legs of ten-inch pipe are slipped over the completed flue unit and the beveled 90-degree joints completed. Last welding operation is the placing of the filler rings which seal off the annular spaces at the ends of the ten-inch and six-inch sections to form an oil-tight chamber surrounding the flue.

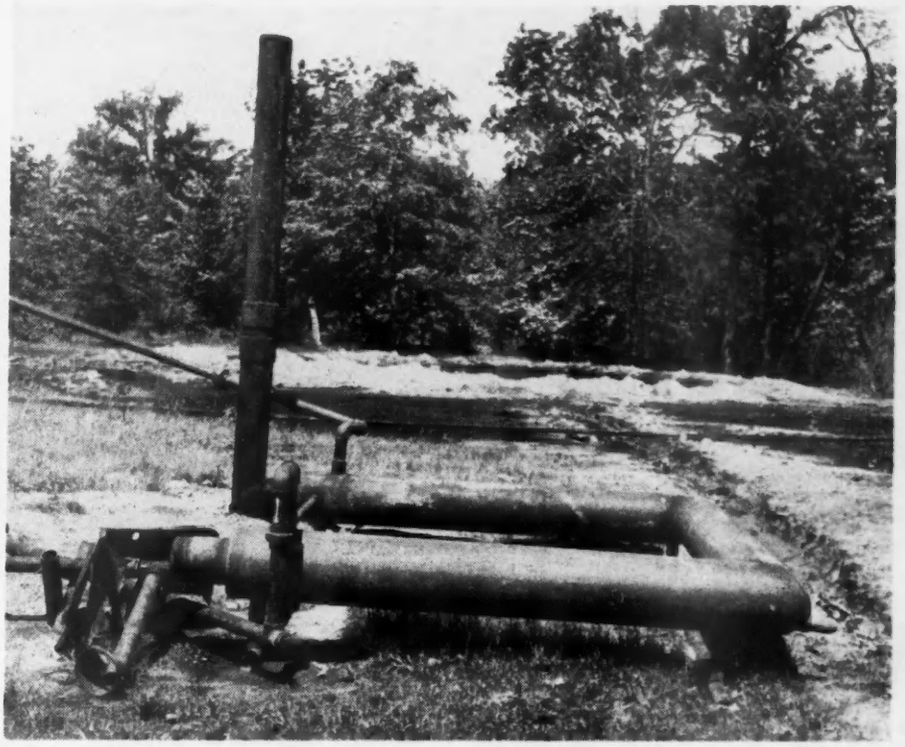

FIGURE 3. U-shaped heater for treating tank bottoms for the removal of sludge and break-up of paraffin formations before they solidify and require expensive maintenance operations. The heater is gas-fired, and circulates fluid through thermo-syphon flow and the added effect of gas bubbles liberated as the fluid in the U-shaped chamber is heated. Bubbles thus formed rise and accelerate liquid motion through the sharply inclined return line at far side of unit.

Both flow lines are brought in on top of the heater to prevent possible clogging at the fittings required to form the two swing joints at the tie-in. Two drain fittings of two-inch pipe welded tangentially to the ten-inch shell, allow either leg of the heater to be drained if desired. These fittings give access to any water which may separate out in the heater when fluid flow to the tank or gunbarrel is arrested after heat is cut off. They also allow the unit to be flushed out in case any deposit forms at or near either of the 90-degree turns.

Pipe Legs Support Heater

The heater is equipped with supporting pipe legs which are tied in pairs to sections of two-inch pipe as long as and paralleling the base of the "U." A tie of 1½-inch pipe, welded between the outer ends of the "U," prevents spreading of the ends and thus protects the angle welds against overstressing. The short stack, of pipe the same size as the flue, is carried on the heater by the rigidity of the welds at the sealed end of the fluid chamber. A collar permits the upper end of the stack to be replaced or its length varied to meet desired draft requirements.

By manifolding both flow and return lines to the different tanks in the battery, with block valves at each branch in the system, the operator is able to switch the flow through the heater to any tank desired, or to return the heated fluid through the gunbarrel for complete processing of the heated bottoms.

Burners used in this type of heater are comprised of a nozzle through which the gas is allowed to flow, the velocity of the gas and the induced stack draft being sufficient to bring in air for combustion of the fuel. The flame is regulated so as to be completely burned out before reaching the first 90-degree turn in the flue, after which heating of the fluid in the chamber surrounding the flue is by transfer from the heated gases on their way to the stack.

Establishment of flow through the unit is readily checked by the temperature of the gases issuing from the stack. There is a decided drop once flow is under way. This change enables the pumper to step up the rate of treatment in the heater by increasing the flow of gas to the burner after the process is started, without danger of scorching or charring any of the fluid in contact with the flue at or near the burner setting.

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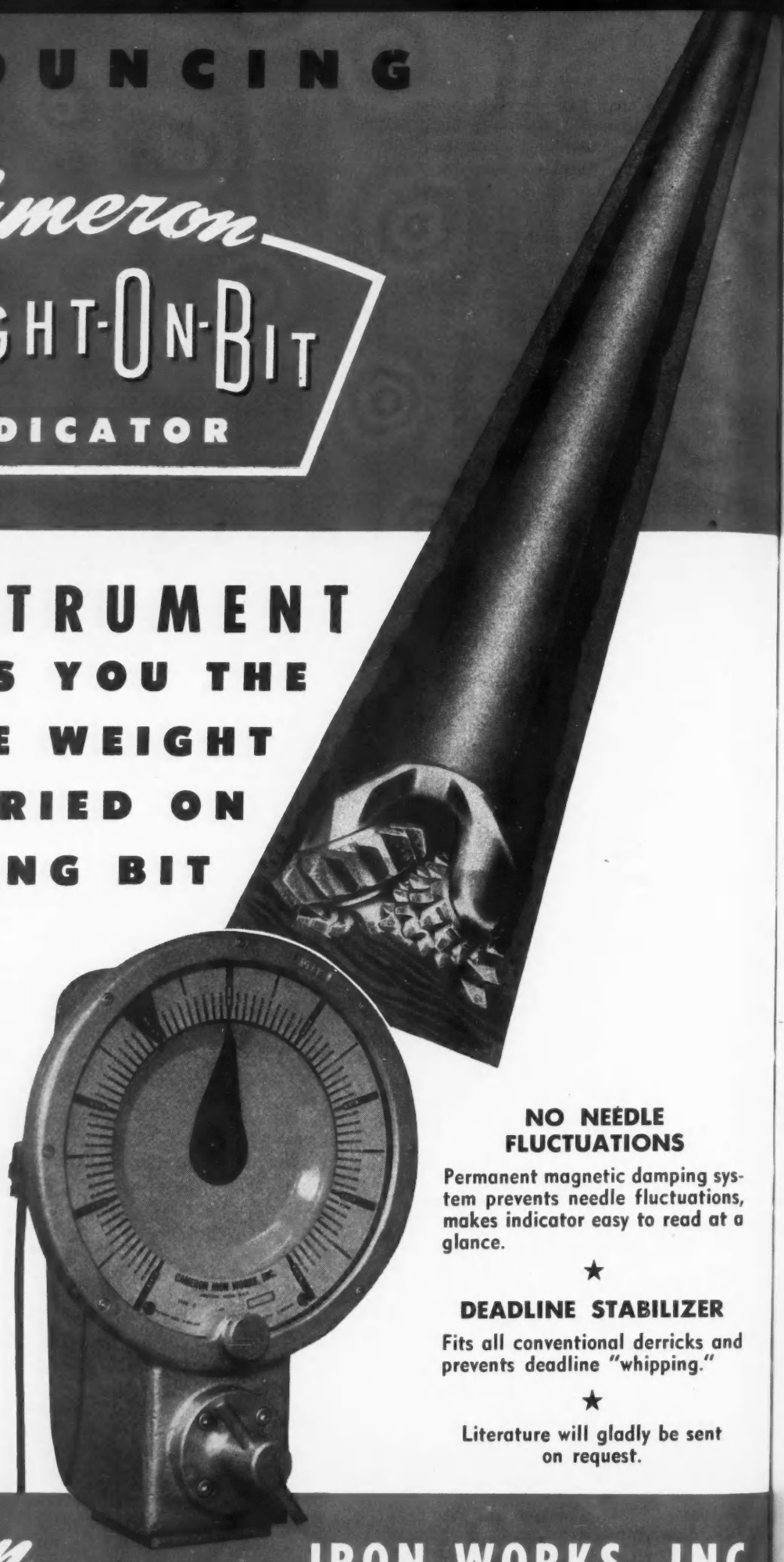

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Transformer Connections For Oil Well Pumping Distribution Systems

By J. N. POORE
Industrial Division General Electric Company

ALTHOUGH delta-delta is the customary connection for oilfield distribution transformer banks, there are in use today quite a number of banks connected wye-delta. The reasons for this condition, its effect on overload protection for pumping motors, and the corrective measures that can be taken to provide adequate overload protection for the motors operated from wye-delta-connected banks, are the subjects of this discussion.

If a pumper or electrician, in examining a motor which may have failed, finds that only one or two of the phase windings have overheated, and then finds that the overload protective relay on the control panel has not tripped, his first reaction probably will be to blame the relay or the motor. Either diagnosis might be correct, but another condition which chould cause the failure is frequently overlooked. This condition concerns the manner in which the transformer bank supplying power to the motor is connected.

Three-Phase Bank

There are several ways in which single-phase transformers might be connected to form a three-phase bank. For the sake of simplicity in explaining this point, assume that the primary distribution system in an oil field is at 12,470 volts, and the secondary supply to the motors is at 480 volts. One of two common types of connections for the transformer bank could be used, namely, delta-delta or wye-delta. If the first type of connection were used, 12,470-volt transformers would be utilized. For the wye-delta connection, 7200 volt transformers would be utilized, wye-connected on the primary side with 7200 volts from line to neutral and 12,470 volts from line to line. The secondary delta voltage would be 480 in both cases.

It is this wye-delta type of transformer connection that, under certain circumstances, can cause a motor burnout from single-phase operation in a rather unexpected manner. The mechanism of failure and a practical preventive measure are described below.

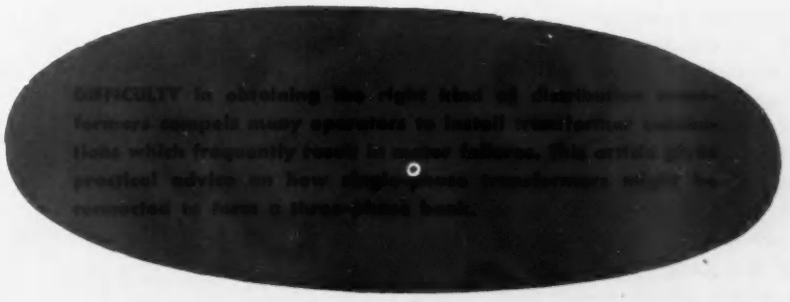
Standard starters for three-phase motors have overload protection in two lines only, and this protection is adequate for most abnormal operating conditions. It cannot be considered wholly adequate when the supply transformer connection is wye-delta (with the neutral point of the primary wye connection isolated), particularly if single-phase fused disconnects are used on the primary side. If the transformer neutral is connected to the high-voltage system neutral, or if a three-phase circuit breaker disconnect is used, two-element overload protection will be sufficient.

Most supply transformers in oilfield distribution systems are protected by high-voltage fused disconnects, and most primary-wye-connected transformers have an isolated neutral.

One important reason for not tying in the neutral point of the wye connection is the possibility of burning out one or two transformers in case a high-voltage fuse blows. Assume that the neutral point of the primary-wye connection on a wye-delta transformer bank is connected to the high-voltage neutral conductor of the line which is grounded. If one phase of the power supply to the transformer bank becomes open, the three-phase bank operates as an open-wye, open-delta bank. This occurs because, under this condition, the correct phase angle and voltage between the two remaining phases is maintained and three-phase power is still supplied on the low-voltage side.

Assuming that the above condition exists and that the transformer bank continues to carry 100 percent three-phase load, then, with one high-voltage phase open, this 100 percent load is being carried by two transformers instead of three. This imposes an overload of 73 percent on the transformer bank. This overload is, in general, not sufficient to cause a high-voltage fuse to blow if normal fusing practice is followed, but, inasmuch as it represents a severe overload on the transformers, it may cause a transformer burnout in a relatively short time.

It may well be asked, why are wye-delta or delta-wye transformer bank connections used? The severe shortage of transformers is partly the reason. The oil industry wants power to operate its wells; the power companies want to do everything possible to provide the oil customer with power. They may have some properly rated transformers which they supply to be operated in banks connected delta-delta, which is the preferred connection to use to avoid the particular kind of motor overheating trouble under discussion. On the other hand they may have some transformers rated at a lower voltage, such as 7200-volt units, which can be operated wye-connected on 12,470-volt primary systems. If the oil customer needs power badly enough, he will ask that these 7200-volt transformers be so connected and used on the 12,470-volt system. He may or may not be aware of the disadvantages of this method of connec-



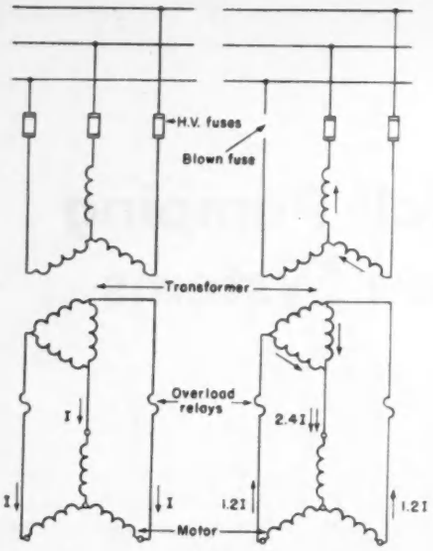


FIGURE 1. Relay and motor winding current distribution for 3-phase and 1-phase supply at same running load where motor winding is Y connected.

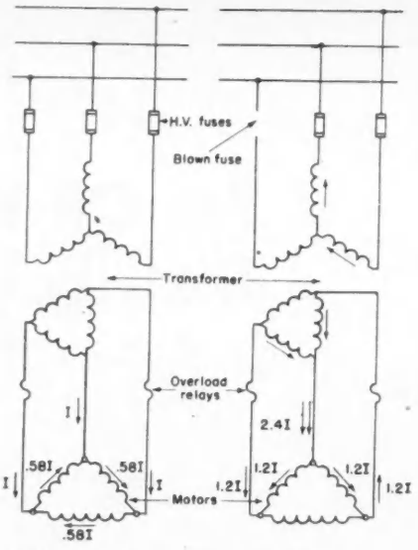


FIGURE 2. Relay and motor winding current distribution for 3-phase and 1-phase supply at same running load where motor winding is delta connected.

tion from the standpoint of motor protection. He is primarily interested in getting his pumps operating and producing oil.

In many instances the oil operator buys his own transformers and because of the extremely tight transformer market, buys whatever he can get.

Motors operated in locations where power is supplied by means of wye-delta-connected transformers, having isolated neutrals and protected by primary fuses, should have three-element overload relay protection to give better protection to the motors and their cable connections.

Consider the circuit connections for wye-delta transformer banks with fused primaries and isolated neutrals. Figure 1 illustrates inadequate protection for wye-connected motors and Figure 2 for delta-connected motors. The protection is deficient because each overload relay is actuated by only half the total single-phase line current, as shown by the arrows on the diagrams, with the particular high-voltage line open. If either of the other two lines had been open, the total single-phase current would shift to one of the low-voltage lines through an overload relay. Thus the relays will give sufficient overload protection in two out of the three cases.

Line current I in Figures 1 and 2 represents three-phase, full-load amperes. The coefficient of I for the single-phase operating condition depends upon the motor design characteristics, and must be determined by the motor designer or by test. It is plain that the single-phase current to a running motor will be 173.2 percent of the three-phase current at the same output, provided the motor power factor and efficiency do not change. However, the motor characteristics suffer rather badly, particularly if the single-phase breakdown torque is only slightly higher than the torque required by the load. Many three-phase motors will not deliver rated output with a single-phase power supply, and if the motor stalls, the line current will be about 86.6 percent of the three-phase locked-rotor line current.

If the motor can carry full load and the single-phase line current increases to 240 percent as illustrated in Figures 1 and 2, then the extent to which the overload protection falls down is suggested by the following comparisons:

The protective relays each sees 120 percent of normal full-load current and will have a long tripping interval, or perhaps may not trip at all because this protection can be applied up to 125 percent of rated current under the National Electrical Code. On the other hand, the current in one phase of the wye-connected motor is 240 percent of normal and in the other two phases is 120 percent of normal. In a similar way the current in two phases of the delta-connected motor winding becomes 208 percent of normal, while the relays see a current of only 120 percent of normal.

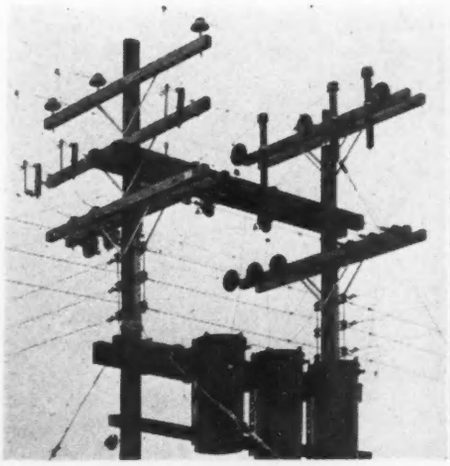
Care Cuts Cost

It can be seen from the above considerations how the damage to the motor from overheating mentioned in the beginning of this article could occur from inadequate attention being paid to the type of transformer connection used. If proper cognizance is taken of this condition and a third overload relay installed in the motor starter, a motor rewind job can be averted.

Oilfield distribution systems are particularly vulnerable to single-phase conditions due to comparatively long exposed distribution lines which are frequently subjected to lightning strokes. Though lightning-protective equipment is employed on the distribution systems, it is still possible for single phasing to take place.

It is suggested to all oil operators that they investigate the transformer connections existing on their various leases, and that wherever isolated wye-delta transformer banks are in use, three-overload relays should be installed in each motor circuit. Three-element overload relay protection will assist in securing uninterrupted production and may constitute an excellent investment in reducing motor rewind expense.

A word of further explanation may prevent some confusion about the need of three-overload devices to protect a motor in the event of a single-phase power supply. It should be understood that a particular type of single-phase supply has been described in this article. If the single-phase supply occurs through opening of a line leading directly to the motor terminals, then two-element overload protection does successfully protect the motor winding against damage.



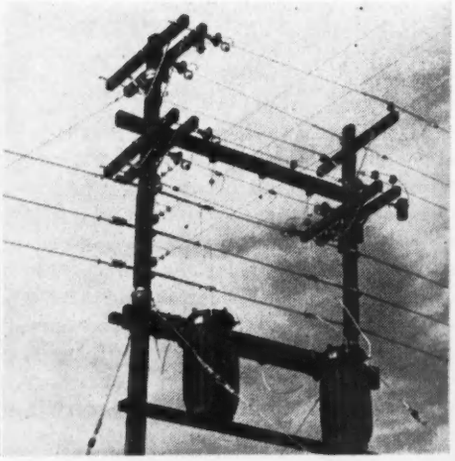
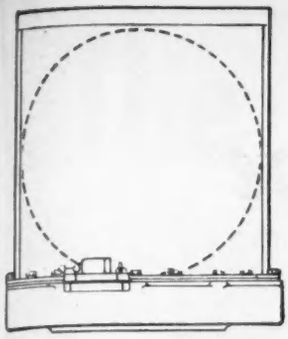
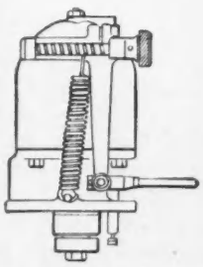


FIGURE 3 (left). Installation of three 25 kva, 12,000/240/480 volt transformers connected delta on primary side and delta on secondary side on a West Texas oil field pumping lease.

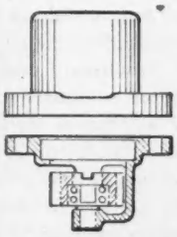
FIGURE 4 (right). Installation of two kva, 2400/240/480-volt transformers connected in an open delta connection on a West Texas oil field pumping lease.



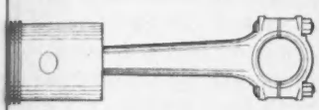
RADIATOR ASSEMBLY



GOVERNOR



MAGNETO & MAGNETO GEAR



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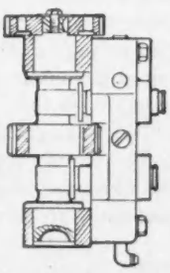
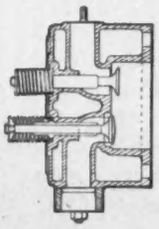


CAMSHAFT AND OIL PUMP



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Hazards in Salvaged Pipe

By F. R. COZZENS
Field Foreman, Equity Oil & Gas Company

RISKS ENCOUNTERED when corners are "cut" in attempting to expedite well completion through the use of salvaged materials may often not only jeopardize the well, but also threaten the life of adjoining properties. The author summarizes measures to be taken and precautions to be observed.

IN THE effort to produce oil at a profit an operator sometimes meets current needs with a measure that carries potential risks. One such measure is the use of salvaged pipe in newly-drilled wells.

The industry's stock-pile of used casing made possible the completion of hundreds of wartime wells, and during various other emergencies before and since the war, salvaged pipe has been a dependable substitute where well completions were necessary at a specified time. Generally, however, emergency privileges are abused, and consequently entirely too much salvaged pipe is being used in lieu of new pipe mainly because of its lower price. Since local competition for such material is keen, inspection rules are lax, and to reduce initial costs still further, it is common practice in many localities to re-run untested pipe without any protective provisions. In fitting up a well, let it be remembered that the casing is the guard-rail between the pump-jack and pay-sand, and weak spots anywhere along the rail endangers the entire route. Those who disregard weakness invite trouble, not only for themselves but also for neighboring operators and those who succeed them. Because of it, every operator in the district must keep his fingers crossed and be on the alert for divers complications which lead to damaged wells. Damaged wells often mean costly repair jobs, and perhaps the loss of thousands of barrels of otherwise recoverable oil.

Precautionary Measures

Salvaged pipe, especially casing, deteriorates rapidly upon exposure to surface atmosphere, and the initial protective step is to clean and oil each section, inside and out. All sections should be rethreaded, and collars examined under a reading glass to make sure that none are pulled, stripped, or cracked. Vigorous use of a wire brush along the section columns will reveal rust pits and corrosive blisters. The final inspection step is to test the pipe under pressure, and any section that fails to reveal a safe working pressure of at least 600 pounds per square inch of surface should be discarded for underground use. Freak, off-gauge pipe or rebuilt sections should never be included in a string of casing.

Prospective purchasers of salvaged pipe, after making sure that inspection measures have been carried out, should examine especially the inside surface of each section for wire line cuts, fissures made by casing rippers or spears, or spots which have been heated and crystallized by the use of explosives during pulling operations. Crystallized spots usually can be detected by lightly tapping along the course of each section with a hammer. After protectors have been returned to the threaded ends, the outside surface of the pipe should be treated with asphalt paint, or a coating of heavy-grade oil. Salvaged casing lacks the "stretch" or elasticity of new pipe and is often damaged in re-running through tight, or crooked sections of open hole, especially on deep well jobs. Driving the pipe through formations which are caving should never be attempted, and it is unwise to "drop" the string when several feet off bottom in an effort to seat or shoulder it, as is sometimes done with new pipe. If there is any doubt about the condition of seat or shoulder, the casing should be run on a packer.

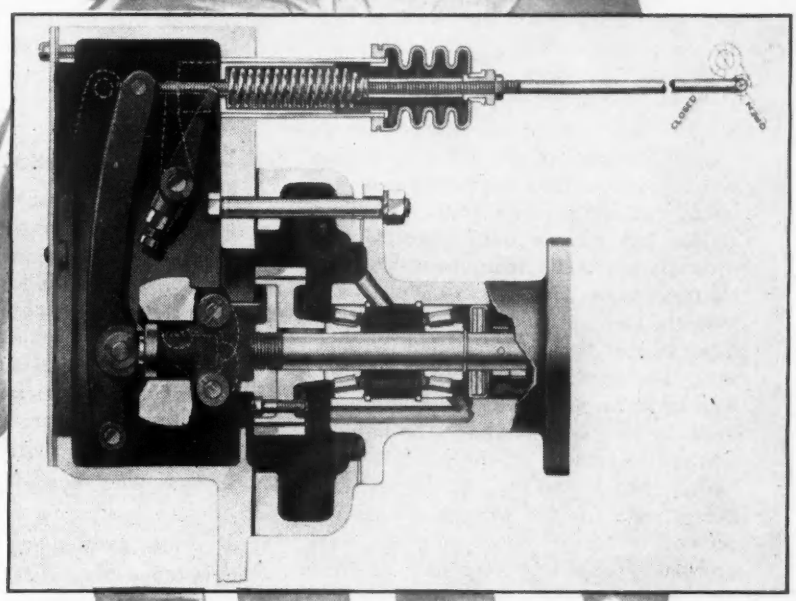
Many operators now make it a rule to run salvaged casing with gel. The practice not only eliminates danger to pipe, but also protects the walls of the well-bore, and takes considerable strain off the mast and lines. The procedure is carried out (after casing point is reached) by running a string of tubing or two-inch diameter line pipe to the bottom of the hole. A six percent gel mixture is then circulated down the tubing and up the outside until the well-bore column is filled to about one-half its length. The tubing is pulled, and the casing started down the hole with a float shoe. As the bottom of the casing submerges in the gel, tension is gradually relieved on the upper sections, and thus friction is reduced as the pipe passes through tight or restricted formations. The entire string can be turned at will, so as to ease collars down over pimples along the walls, and through crooked stretches of hole, or lime shells. If downward motion becomes too slow, water is poured into the casing to provide additional weight. By the time, or shortly before, the casing reaches the bottom of the hole it will have replaced the gel to the top, so that a protective coating surrounds the entire column of pipe. By filling the well bore from the bottom upward, all formations are packed off and compressed, and there is no caving as might be the case were the gel mixture poured down over the walls from the top.

In shallow sand wells (800 feet or less) gel is sometimes replaced with a very thin slurry of native clay for easing down an outer string of salvaged casing. Mud provides the desired cushioning effect, but a common objection is that clay is likely to settle over the casing shoulder so as to make tight seating impossible. Once the clay has hardened around the pipe, any future attempts to salvage it are usually futile.

Remedying Defects

After a few sections of salvaged casing are lowered into a well, increasing tension is likely to reveal defects which were not noticed on previous inspection. The weakest spots in most strings are the collars. Those which have been hammered severely in salvaging are likely to spread under tension. Any section which fails to join up with a snug thread should have its collar replaced with a new one. In some cases it is advisable to weld the sections together, especially in wells where the pipe is to be "hung" or tension taken at the top. Any section which flattens at the ends or pulls under tension should be taken out of the string and used as drive pipe. If it is definitely known that certain for-

The PUMPER'S HELPER



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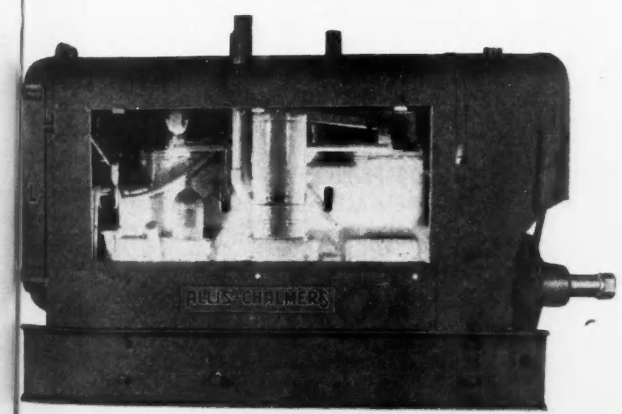

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mations along the well bore are giving off sulfur or other corrosive mineral water, such stretches of hole should be faced with the best sections of pipe in the string. In all such cases a gel mixture should be introduced around the pipe to isolate the corrosive zones. Encroaching fluids, as a rule, do not migrate through the gel.

Alertness Necessary

An alert eye should always be kept on wells containing salvaged casing, especially upon those where pipe has been run without protective measures. This includes wells containing thin wall line pipe which was often placed in strings of salvaged casing during the war. It is an operator's duty not only to inspect such wells, but also to see that neighboring operators do likewise because one damaged well can have detrimental effects on all other wells in that locality. The initial indication of well damage from salvaged pipe is generally the presence of some fresh water at the beginning and close of the pumping period. In wells where the tubing has been raised, or is held several feet off bottom, fresh water seepage can exist unobserved for weeks and months, or until the pocket and lower stretches of shot hole are completely water-coned. Fresh water, unless under pressure, seldom penetrates a sand for any great distance but even a small area of water-head is often sufficient to create a Jamin action back of the sand face so that considerable quantities of oil are trapped or held up. Oil can never be forced through a fresh water barrier by any driving medium known, so all production thus trapped is lost entirely unless the water barrier is broken up. The initial procedure, however, is to learn whether the water is coming from leaks in or around the casing of the damaged well, or is filtering into the sand from neighboring wells or abandoned holes.

Use of Dyes

The customary way of finding out is by the use of dyes. One-half pound of highly colored dye, preferably red, is stirred into five gallons of hot water. When the dye pigment is thoroughly dissolved, more water is added so as to provide a quantity of 12 to 15 gallons. This is poured around the outside of the casing, and if leaks exist, dye water will invariably be noticed at pumping times. Operators are sometimes successful in repairing casing leaks with cement, using a spray-gun along the inside surface of damaged section, and a quantity of cement-slurry for leaks at casing shoulder. The most practical method, however, is to run an inner string of casing or three-inch diameter tubing on a packer to the top of the pay. Before any packers are set, water-coned wells are given revival treatments, and this generally requires the aid of cleanout tools. The usual procedure is to stir the residue with the drill and bail out the shot-hole dry as possible. The operator then selects one of four reviving agents: acetone, hydrochloric acid, brine, or air or gas under pressure. Commercial grade acetone, because of its ability to extract water from certain constituents of the sand-structure, and to stimulate capillary action, has proven quite successful in reviving gas wells temporarily "killed" by fresh water. Its use in oil wells follows the same procedure, except that no lubricator or syphoning system is necessary. The acetone is measured into the well by bailer provided with a dump-rod until the shot hole is filled. The liquid is allowed to remain on the sand 12 to 24 hours, then bailed out. If the well has been "watered-out" for some weeks, a second or third application of fresh acetone is generally necessary before a satisfactory oil flow returns. Since it is less difficult to obtain, many operators prefer to use a solution of hydrochloric acid. The acid solution with inhibitors is measured into the well in exactly the same manner as acetone, but the treatments are drawn out, the acid being left on the sand for three day periods before bailing out. Ten to 12 days usually are required to complete the series of necessary applications. Brine is mainly used on wells where oil flow has been curtailed or somewhat restricted by recent intrusion of fresh water. Brine for the purpose is made up on the job, in proportions of 100 to 150 pounds of dry granular salt stirred into each barrel of water needed to fill the shot hole. Brine is stirred vigorously with the drill every three or four hours and bailed out at the end of 12-hour periods. The action of both acid and brine tends to shrink and compress the various clay elements which are a part of most sand structures, and to render these elements to a more flocculated or pliable condition. This action opens clogged pores in the sand face so that trapped oil can escape into the well. If air- or gas-pressuring equipment is available, or a portable compressor capable of providing a pressure of 500 or more pounds, the most practical method of eliminating a water head is by temporary induction of air or gas. It is generally believed that fresh water penetrates a sand fairly uniformly in all directions out from the shot hole, and thus forms a ring, the center of which is the base of the well. If pressure is applied through the shot hole, the water ring expands and is pushed farther into the sand, but in such expansion its walls become thinner and eventually break. When a break occurs at any point, tension is relieved, and sand energy forces oil through the broken-down barrier. Water is forced along with the oil to the shot hole and is gradually pumped out. A temporary induction of pressure will accomplish this purpose, usually within one to three weeks, after which the induction pipe is removed, and normal pumping resumed.

Casing Scale

One stubborn agent which generally complicates a fresh water encroachment is casing scale. This residue is always present, usually in the form of splotches or blisters along the inner surface of uncleaned pipe. It is mainly composed of oxidized elements which first cause trouble by cutting out cups, and clogging seats and working barrels. If present in sufficient quantity, it later spreads to the sand face with considerable plugging effect, and has more or less corrosive action on the pumping equipment. Casing scale is especially potent in fresh water, and this is a very essential reason why the shot holes of all damaged wells should be cleaned out thoroughly. If scale is much in evidence, it is sometimes necessary to circulate a quantity of hydrochloric acid without inhibitors into the pocket or lower zones of the shot hole where the residue accumulates. The acid neutralizes certain corrosive constituents of the scale mass and forms a sludge which is easily bailed out. Acid should remain in the hole six to ten hours before any bailing is done, and several wash-downs with brine are advisable afterward to remove all un-spent acid from the well.

Repairs Justified

Repair jobs resulting from bad casing cost anywhere from $50 to $500, but considering the fact that without such action, a well is a total loss and a menace to the locality, the investment is justified. Wells deemed not worthy of repair and treatment should, upon discovery, be pulled out and plugged. Repaired wells generally pay out, and often become valuable assets in future oil recovery patterns. A few well-repair jobs in a locality serve also to make operators casing conscious. While salvaged pipe must continue to be used in various wells, there will be closer inspection, protective measures, and a general tendency to run only the better grades. By following this practice, first-cost savings become permanent benefits. The ultimate result is lower operating costs and a more dependable production of oil.

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Peak Tension Ratings For V Belts

DEVELOPMENT OF a method for rating and selecting V-belts for pumping unit drives is here outlined, with recommendations leading toward more effective selection with reduced data as compared to existing belt data tabulations.

By D. O. BARRETT
Gulf Oil Corporation

THE peak-torque method of rating flat-belt drives has been proved in three years of field service. It was adopted by the API and included in API Std. 1, Tenth Edition, September, 1947 as Appendix D. As suggested by a number of critics, the peak-torque method should include ratings for V-belts as well as flat belts, since a majority of the pumping-unit belt drives employ V-belts. This was the original intention of proponents of the peak-torque method.

It was necessary first to establish the method of performing the various operations and also to establish the accuracy of such a system in actual practice. This has now been accomplished and the peak-torque system has proved very desirable. It enables the choice of a belt drive for a pumping unit to be made along simple and direct engineering lines, and the rating values supplied by the manufacturers are more readily usable than other figures. The results of this experience with the rating system on flat belts have emphasized several facts; (1) belt selection is simpler; (2) better drives are designed; (3) the manufacturer's belt rating represents a more accurate and usable value than any other; (4) the deficiencies in belt drives are more readily ascertained; (5) the minimum expected life is readily determined; and (6) a satisfactory basis is established for adjustment in case of premature failure.

The accumulation of data used in connection with the flat-belt ratings consisted of a large number of field tension tests, manufacturers' data on breaking strength of this type of belt, and years of experience with flat-belt drives. It has been impossible to obtain such data from the V-belt manufacturers and, consequently, the only basis available for determination of allowable peak tensions has been the standard V-belt horsepower tables. Accordingly, the data presented in the illustration were derived from the standard V-belt horsepower rating tables in the API Standard 1. The tensions given in the table have been calculated for a belt speed of 1000 feet per minute and these have been used as base values.

Authority for the determination of tensions in this manner, and the method used to calculate the tensions, will be found on page 129, Production Bulletin No. 231, Proceedings of the Twenty-Fifth Annual Meeting, API, Chicago, November 12-15, 1945.

"The horsepower tables as published in the API Belting specification are already based on peak-load conditions. That is the reason for the so-called overload factors given on p. 55 of API Std. 1. Therefore, when the momentary peak load is known and used against the horsepower tables, the overload factors are, of course, not required. If the momentary peak-horsepower load is not known, and if it is desired, work on a peak-tension or a peak-torque basis proceeds as follows:

$$\text{Peak-tension} = \frac{1.5\ (33{,}000)\ (\text{hp rating})}{\text{rating per belt} \quad \text{fpm of belt speed}}$$

The 1.5 factor is used because the tight-side tension needs to be only 1.5 times effective tension as compared with a factor of 2.0 for flat belts."

Peak-tension calculations were made for each of the other belt velocities given in the horsepower tables and curves were drawn for each size of sheave and section of belt. It was found that these curves were so well grouped that an average curve could be drawn to represent the allowable belt tension at any speed up to 4000 fpm, as related to the allowable tension at 1000 fpm. The error resulting from the use of an average curve is so small as to be acceptable for belt design. This curve is termed Speed Correction Curve and, from it, Speed Correction Factors for belt speeds above 1000 fpm may be obtained. Arc of Contact Correction figures given in the lower right-hand table are the same as those appearing in API Std. 1. To obtain the net peak-tension rating, multiply the peak-tension value from the table at the top of the page by applicable Speed Correction Factor and Arc of Contact Correction Factor.

To illustrate the employment of the peak-torque method in the selection of a V-belt drive, an example is taken from Paragraph 13, Page 31, Appendix D, API Std. 1, Tenth Edition, September, 1947.

"Case III; Belt m—New Design

13. Data: Peak torque capacity of reducer = 260,000 in.-lb.; gear ratio (G_r) = 10.3; well will be operated 25 strokes per min.; distance between gear-reducer frame and end of crank pin, 11½ in.; maximum radial clearance from high-speed shaft to reducer frame, 21½ in.; capacity of belt drive must equal that of gears. In order to allow space for a metal belt-enclosure, largest diameter of driven pulley that can be used is 40 in. and greatest width of pulley 10¾ in.; therefore, pulley radius (r_2) = 20 in. and belt width (w) cannot be wider than 10 in.

Equivalent peak torque at high speed shaft = peak torque of the reducer, therefore:

$$\text{Total effective tension} = \frac{260{,}000}{G_r \times r_2}\ \text{(Formula 10)}$$

$$= \frac{260{,}000}{10.3 \times 20} = 1262\ \text{lbs."}$$

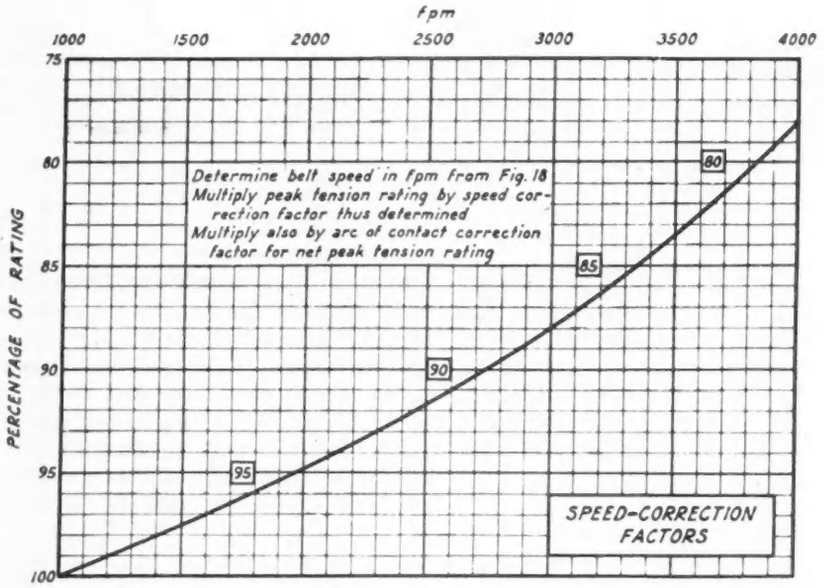
In addition to the data given, a 13-

PEAK TENSION RATINGS FOR STANDARD V-BELTS
OIL-FIELD PUMPING SERVICE
AT 1000 FPM

PITCH DIAMETER SHEAVES	5.0	5.4	5.8	6.2	6.6	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0
B-SECTION	64.5	69.0	74.0	79.0	84.0	89.0																			
C-SECTION						99.0	124	138	153	168	178														
D-SECTION											223	253	277	302	322	337									
E-SECTION																	396	421	445	465	485	505	520	539	549

Above rating in lb per belt

$R = 3.0$; $T_t = 1.5\ T_e$



POWER-CORRECTION FACTORS FOR ARC OF CONTACT

ARC OF CONTACT	CORRECTION FACTOR	ARC OF CONTACT	CORRECTION FACTOR
180°	1.00	127°	0.85
175°	0.99	124°	0.84
170°	0.98	120°	0.83
167°	0.97	118°	0.82
164°	0.96	115°	0.81
160°	0.95	113°	0.80
157°	0.94	110°	0.79
154°	0.93	108°	0.78
150°	0.92	106°	0.77
147°	0.91	104°	0.76
144°	0.90	102°	0.75
140°	0.89	100°	0.74
137°	0.88	98°	0.73
134°	0.87	96°	0.72
130°	0.86	94°	0.71

Arc of contact should be based on the effective arc as determined by the following formula:

$$\text{Arc of contact} = 180 - \frac{(D-d)\times 60}{C}$$

Where D = Pitch diameter of large sheave, inches
d = Pitch diameter of small sheave, inches
C = Center distance of drive, inches

Date 3-1-48

inch PD D-section sheave will be used on an engine operating at about 800 rpm.

The peak-tension rating for a D section belt operating over a 13-inch PD sheave (table at top of page) is 253 pounds at 1000 fpm. Speed Correction Factor at 2690 fpm is 0.90 and Arc of Contact Correction Factor using D-210 V-belts is 0.93 (154°). The net peak-tension value is, therefore:

$$253 \times 0.90 \times 0.93 = 212 \text{ lb.}$$

V-belt design is based on a tension ration of 3.00. Hence, the effective tension ($T_e = 1262$ lb.) must be multiplied by 1.5, ($T_t = T_e \frac{R}{R-1}$ or $T_t = 1.5T_e$) to obtain the total peak tension required.

$$T_t = 1.5\ T_e = 1.5 \times 1262 = 1893 \text{ lb.}$$

Since the net peak-tension rating is 212 lb. per D-section belt, the number of belts required is:

$$\frac{1893}{212} = 8.9 \text{ use 9 D-section belts}$$

The width of a 9 D-section sheave is 13¼ inches, while the maximum width of sheave or pulley which may be used with this gear reducer is 10¾ inches. Therefore, a 7 D-section sheave, 10⅜ inches in width, is the widest D-section sheave which may be used. The lack of space for adequate drive pulleys or sheaves, both in diameter and width, is a common deficiency of many gear-reduction units, particularly those of the single-reduction type. Unit-pumper manufacturers should be requested to equip their gear- or chain-reducers with adequate drive capacity. The method proposed supplies a ready means of determining the required sheave size in the simplest possible manner.

Simplicity Added

The simplicity of this method with its one rating table is self-evident when compared with the various tables using horsepower as a basis of rating. Some handbooks devoted to V-belt practice actually carry four separate and distinct sets of horsepower tables for the different types of service encountered. Others contain tables or lists of factors to be used for various applications. Each table is further amplified with foot-notes covering continuous or part-time operations, wet conditions, use of idlers, speedup drives, etc.

These voluminous horsepower tables become obsolete as soon as a new belt is built having greater load-carrying capacities than those for which the tables were calculated. In the proposed method, when the belt-tension capacity is increased, a new rating table, such as that given at the top of the page, is supplied by the manufacturer.

The peak-torque system contains but one set of values, few in number and easily presented in brief tabular form. All of the pertinent data required for employment of this method are presented on one side of a standard size sheet. It is brief, direct and simple to use. No factors for various conditions and types of service are required, for the reason that the peak-torque method is designed for use in selection of belt drives for beam pumping of oil wells.

Engineers' and manufacturers' belting committees have expressed the opinion that flat belts and V-belts should be rated in a like or similar manner. The peak-torque method of rating flat-belt drives for oil-well pumping has been adopted by the API and is included as Appendix D in the Tenth Edition of API Std. 1, September, 1947. Now a successful system of rating flat belts has been established, proved in the field and adopted by the API. It is therefore proposed that a like method of rating V-belts for oil well pumping, as set out herein, be adopted by the API.

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Condensate PRODUCTION AND CYCLING

Part 17

Cycling an Elongated Reservoir

A CYCLING program is mapped out for a reservoir having a 2:1 length ratio of major to minor axes. The optimum initial rate of condensate production is about 10.4 percent per year of in place condensate.

Structure and Stratigraphy

Consider the reservoir mapped out in Figures 17-1 through 3. This is an elongated structure and is called the E-1 reservoir. The major axis is about twice the length of the minor axis. The closure is 200 feet. The sections shown in Figure 17-2 are W-E and N-S through the apex.

The pay thickness contours are shown in Figure 17-3. The productive area is 6220 acres. These are 217,700 acre-feet of pay. Pay thickness averages 35 feet. The uniform stratigraphy is for illustrative purposes only.

The Basic Data

The basic data for the E-1 reservoir are itemized in Table 17-1. A 24 percent porosity, 400 millidarcy permeability and 20 percent interstitial water are assumed for illustrative purposes. There are 22,640,000 barrels of condensate in place. The in-place rich gas is 450.9 billion feet.

TABLE 17-1
Basic Data for The E-1 Reservoir

Productive area, acres	6220
Average pay thickness, ft	35
Acre-feet of pay	217,700
Length of major axis, ft	25,080
Length of minor axis, ft	12,540
Average depth, ft	10,600
Average porosity, percent	24
Average permeability, mds	400
Average interstitial water, percent	20
Reservoir space, bbls./acre-foot	1490
Reservoir space, million bbls.	324.37
Reservoir pressure, psia	4660
Reservoir temperature, °F	220
BPMM at 4660 psia	50.2
Bbls. space/bbl. C_{4+}	14.33
In place C_{4+}, million bbls.	22.64
MCF of rich gas/bbl. C_{4+}	19.92
In place rich gas, billion ft	450.9
MCF of propane and lighter/bbl C_{4+}	19.07
In place propane and lighter, billion ft	431.7

By PARK J. JONES
Consultant

One barrel of butanes plus occupies 14.33 barrels of reservoir space and 19.92 Mcf of rich gas yield one barrel of butane plus. The volume factor is 0.719 barrels of space per Mcf of rich gas. The compressibility factor for the rich gas is 0.978. Rich gas gravity is 0.714, see Table 17-2.

TABLE 17-2
Rich Gas B Molecular Weight and Gravity

Component	Y	M	MY
Methane	91.06	16	14.570
Ethane	3.21	30	0.963
Propane	1.47	44	0.647
Isobutane	0.46	58	0.267
N-Butane	0.61	58	0.354
Isopentane	0.32	72	0.230
N-Pentane	0.16	72	0.115
Hexanes	0.42	86	0.361
Heptanes +	2.29	155	3.550
	100.00	....	20.696=M

Rich gas gravity=20.696/29=0.714

TABLE 17-3
Estimated Drawdown for 30 Million/Day

Reservoir pressure, psia	4660
Reservoir temperature, °F	220
Compressibility factor	0.978
Viscosity, centipoises	0.027
Well interference factor	0.64
Half distance to injection wells, d, ft	12,000
Radius of well bore, r, ft	1/3
Log 2d/r = log 36,000	4.56
Completion in pay, ft	40
Permeability at 0.8(0.4), darcys	0.32
$P^2_r - P^2_b$, million	0.983
P^2_b = 21.716 — 0.983	20.733
P_b, psia	4553
Drawdown, psi	107

Producing Rates and Pressure

In order to estimate the drawndown, assume a 30 million per day producing rate. The the bottom-hole operating pressure P_b may be obtained as in Table 17-3. A 107 pounds per square inch drawdown is likely to produce 30 million per day into a well.

In view of the reservoir capacity, four-inch nominal size tubing may be used for producing wells. The approximate producing wellhead pressures (see Table 17-4) for 40-60 million per day per well range from 3200-2600 psia.

Injection Rate and Pressure

There are 957.4 Mcf of propane and lighter per million cubic feet of production aside from condensation and contamination. The properties of the residue gas are shown in Table 17-5. The volumetric withdrawal per million feet of rich gas is 978 Mcf. This is also the

TABLE 17-4
Producing Wellhead Pressure for 4-Inch Tubing

Length of tubing, ft	10,600		
Average temperature	180		
Average compressibility factor	0.95		
Gas gravity	0.714		
S=0.0375(0.714) (10,600)/640(0.95)	0.467		
e^S	1.595		
$15.1/D^{5.23}$	0.0113		
$R=0.0113\frac{640(0.95)Q}{}^2$	$0.00418Q^2$		
Million/day/well, Q	40	50	60
$F=0.0328Q$, million	1.312	1.640	1.968
P^2_b, million	20.404	20.076	19.748
P_b, psia	4516	4480	4444
Estimated drawdown, psi	144	180	216
R in millions	6.688	10.450	15.048
$R(e^S-1)$	3.979	6.218	8.954
$E=F+R(e^S-1)$	5.291	7.858	10.922
$P^2_w e^S = 21.716 - E$	16.425	13.858	10.794
P^2_w in millions	10.298	8.689	6.740
Estimated P_w, psia	3200	2950	2600

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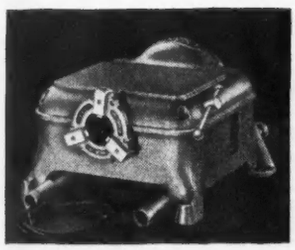

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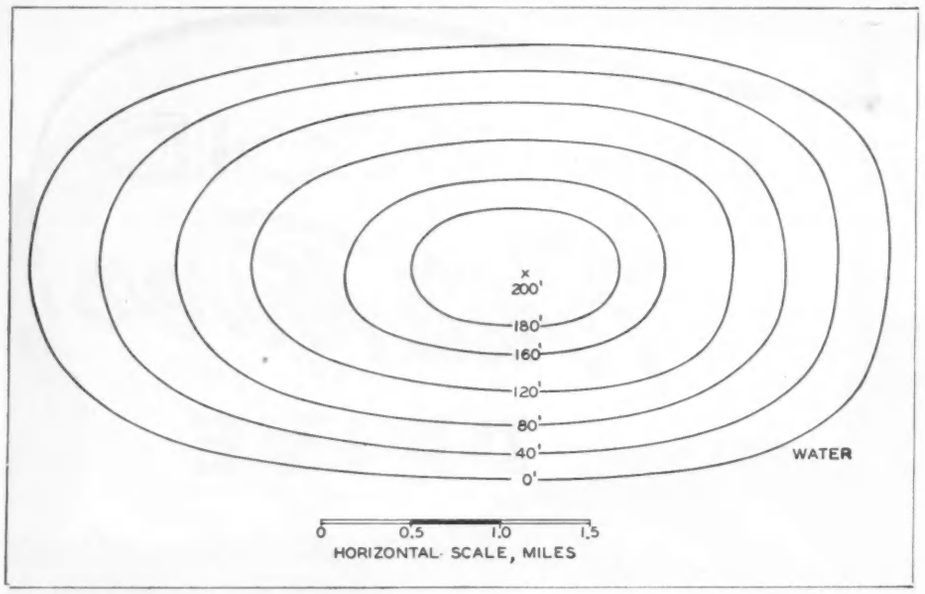

Figure 1. Contours on top of the E-1 reservoir.

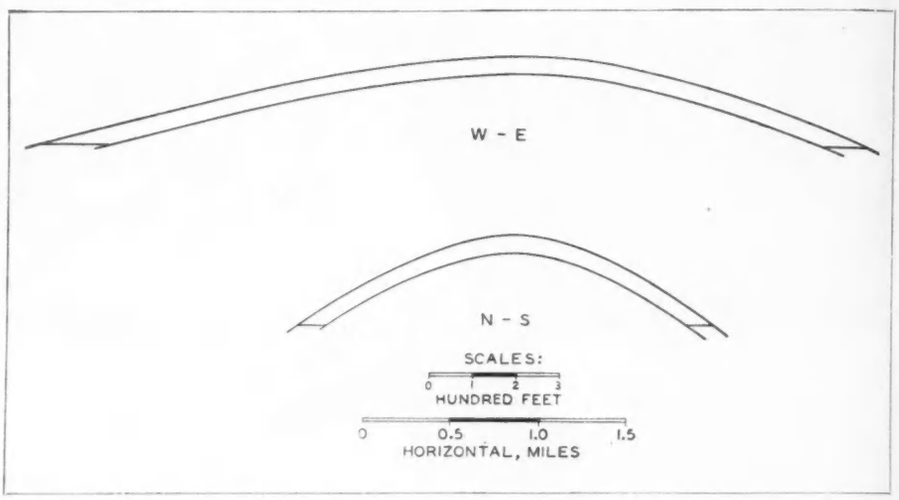

Figure 2. W-E and N-S sections through the apex of the E-1 reservoir.

required injection gas per million of production. The available residue gas after shrinkage and fuel is about 900 Mcf per million of production.

The estimated buildup at 40 million per day per well is 132 psi aside from plugging, Table 17-6. The approximate injection wellhead pressures for 30-50 million per day per well range from 4150-4480 psia, Table 17-7.

The Optimum Cycling Rate

Let the producing rate be 50 million per day per well for optimizing the E-1 reservoir cycling rate. As a first approximation, use four injection wells per three producing wells. The gross annual income per producing well is 1.8(50) (50.2) (365) or $1,649,000. The per producing well investment at $100,000 per well is $233,000 for wells and 35,000(50) or $1,750,000 for plant. The total is $1,983,000. So the ratio X of income to investment is 1649/1983 or 0.832.

Let the sum of taxes, royalty and operating expenses equal 25 percent of gross production. Then the product X(1—B) is 0.624. The corresponding uniform rate of production is 8.6 percent per year of the reserve recoverable prior to breakthrough of dry gas. Assume for the moment that breakthrough recovery will be 50 percent. Then the contribution to the optimum rate of cycling by the condensate recoverable at a uniform producing rate is 0.5(8.6) or 4.30 percent per year of in place condensate.

The cycling economic limit is 15 barrels per million. The composition of production at cycling economic limit is 15/50.2 or about 30 percent. The produced rich and dry gas at economic limit will be about 110 percent of in place gas. The corresponding condensate recovery is about 77.7 percent. The difference (77.7 — 50) or 27.7 percent is the condensate recoverable during the time composition declines from 50.2 to 15 bpmm. Cycling outgo will increase from 25 to 100 percent at the economic limit. The equivalent income (1 — E) will be about 50 percent of uncontaminated gross income. The product X(1 — E) is 0.416. The contribution to the optimum rate of cycling by 27.7 percent of the in place condensate is 0.94(0.277) (8.6) or approximately 2.24 percent per year of in place condensate.

The optimum rate of cycling on the basis of the foregoing assumptions and relative to condensate alone is 6.54 percent per year. The corresponding daily rate of rich gas production is approximately 77 million per day.

TABLE 17-5
Properties of Injection Gas

Constituent	Methane	Ethane	Propane	Total
Mole, percent	95.11	3.35	1.54	100.00
Gas gravity	0.554	1.038	1.522	0.585
Critical pressure	673	712	617	673
Reduced pressure, 4660/673	....	....	....	6.92
Critical temperature	344	550	666	356
Reduced temperature, 680/356	....	....	....	1.91
Compressibility factor	....	....	....	1.00
Available after shrinkage and fuel	....	....	....	0.90
Withdrawal, MCF/million of rich gas	....	....	....	978
Required injection gas, 978/1.00	....	....	....	978
Available injection gas, MCF/million	....	....	....	900

Influence of Sales Gas

Injection gas after shrinkage and fuel is about 900 Mcf per million. After breakthrough, the decrease in shrinkage about offsets fuel consumption for injection of recycled gas. The probable in place gas at cycling economic limit is about 90 percent or about 406 billion.

In place value of condensate is 1.8-(22.64) or $40.75 million. The condensate reserve is 77.7 percent. The estimated sales gas is 94 percent of 406 or 382 billion. The value of this gas at four cents per Mcf after taxes, royalty and operating expense is $15.3 million. The estimated value of in place condensate after taxes royalty and operating expenses is 40.75(0.777) (0.66) or $20.9 million. By equation (5) in part 14,

$$Q = 6.54\,(1 + 0.8\,\frac{15.3}{20.9} = 10.4$$

The corresponding optimum rate of cycling is 0.104(450.9)/365 or 128 million

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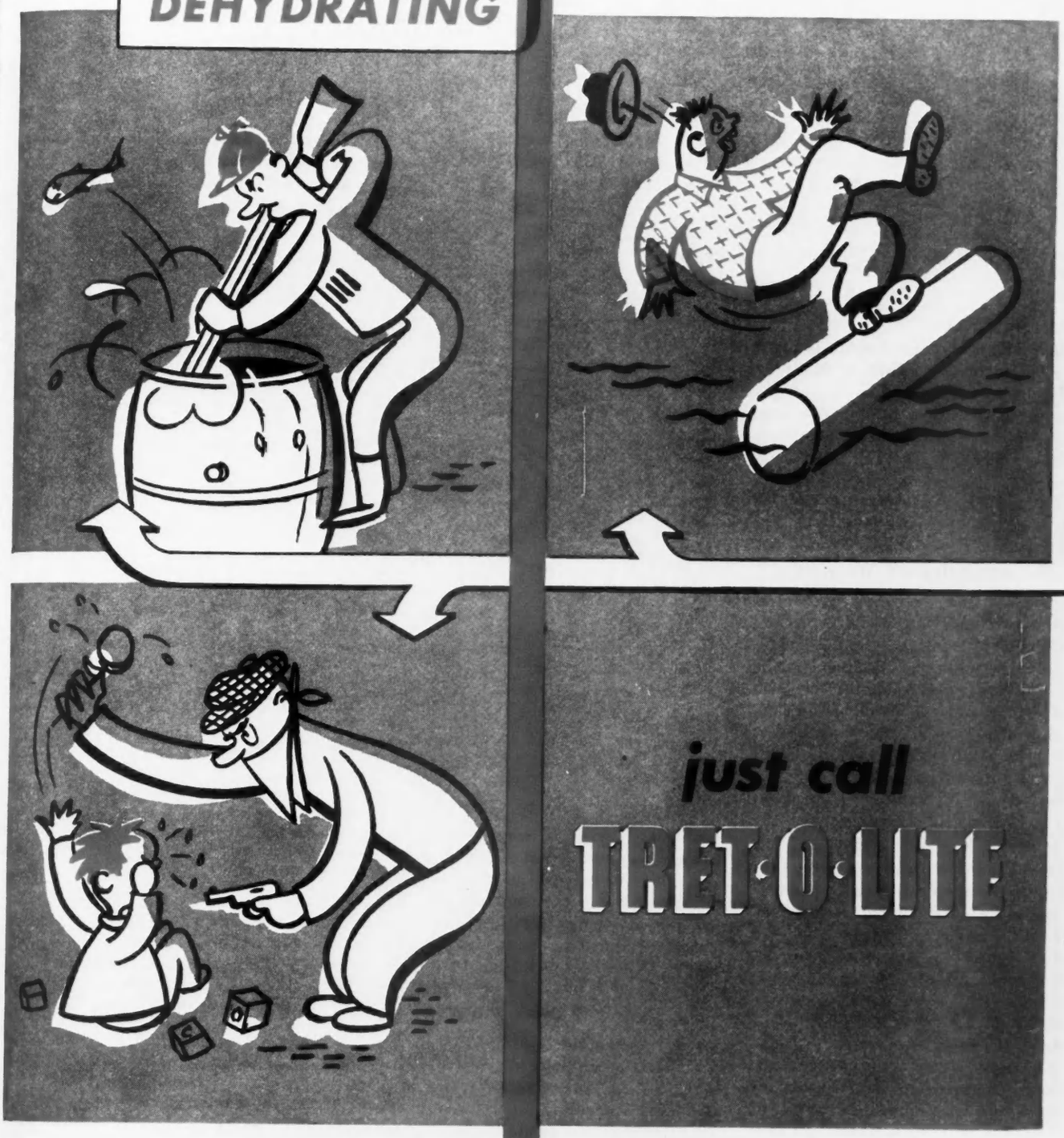

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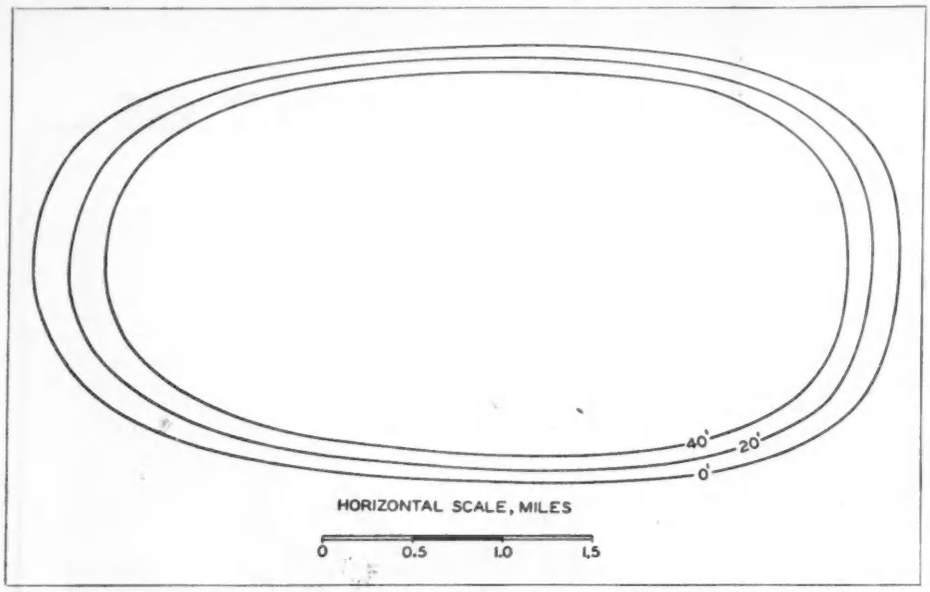
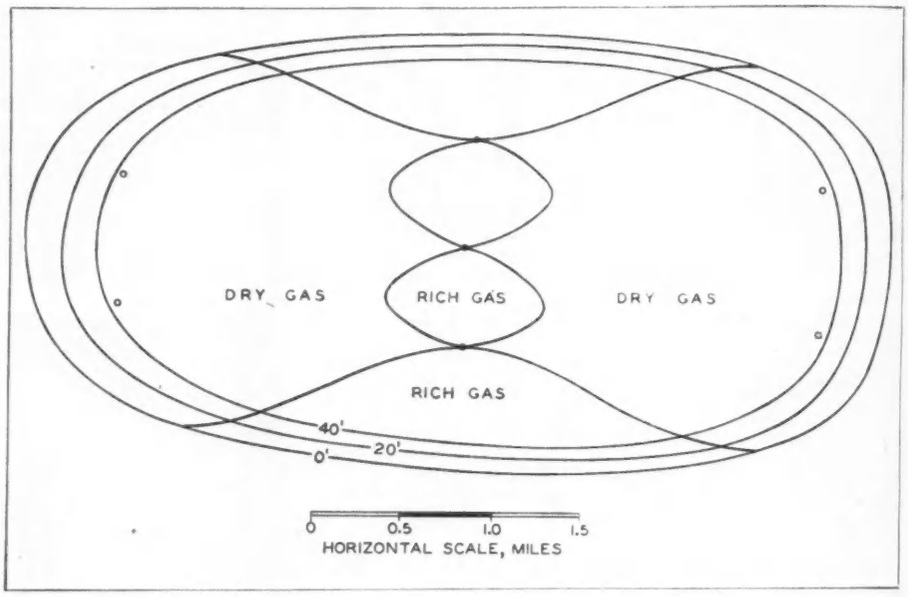


Figure 3. Pay thickness in the E-1 reservoir.

Figure 4. A cycling program for the E-1 reservoir; produce 108 million per day from three wells; inject 115 million per day through four wells; condensate rate is 6400 barrels per day.

per day. The rate of condensate production prior to break-through is 50.2(128) or 6400 barrels per day. The rate of gas injection is about 115 million per day. Three producing wells are required. By virtue of injection rate and the shape of the E-1 reservoir, four injection wells are needed. The suggested cycling program is shown in Figure 17-4.



The Break-through Recovery

If the distance between the central and the two structurally-lower producing wells were increased, the non-invadable area between the producing wells would increase and would be likely to offset the increase of invadable area on the downdip side of the structurally-lower producing wells. On the other hand, gas production after cycling requires wells. With workovers, the locations in Figure 17-4 can produce the E-1 reservoir to abandonment.

The break-through recovery for uniform permeability and per-well injection rate proportional to per-well invadable acre-feet would be about 70 percent of in place rich gas. However, break-through via all intervals into three wells from two sides is not likely to be simultaneous. Dry gas will break through via one interval from one side into one well. But the decline in composition will be nominal until several intervals break through into three of the wells. In view of which, the break-through recovery is not likely to be less than the 50 percent used above for optimizing the producing rate provided per-interval permeability ratios are essentially uniform across the distance between producing and injection wells.

TABLE 17-6
Estimated Buildup at 40 Million/Day

Reservoir pressure, psia	4660
Reservoir temperature, °F	220
Compressibility factor	1.00
Molecular weight	16.97
Viscosity, centipoises	0.025
Well interference factor	0.64
Completion efficiency, percent	50
Well-reservoir permeability, darcys	0.32
Log 2d/r	4.56
Completion, ft./well	40
$P^2_b - P^2_r$	1.241
$P^2_b = 21.716 + 1.241$	22.957
P_b, psia	4792
Buildup, psi	132

Control of Break-through

The composition of production at the cycling economic limit for the E-1 reservoir is about 30 percent of the 50.2-bpmm initial composition. As neither the injection nor the producing wells are overloaded, the program in Figure 17-4 is flexible. The available control will now be indicated.

Pass a vertical plane through the three producing wells. Planimeter the acre-feet on the E and W sides of the plane. For simultaneous break-through, the E and W injection rates are proportional to the acre-foot ratio. But in order to know whether break-through is from E or W, inject at, say, a five percent disproportional rate. Break-through will be from the side having the faster injection rate.

Produce the two structurally-lower wells at, say, 32 percent each and the central well at 36 percent of the total rate. Pinch in the first and second break-through wells. After break-through into all three wells, reverse injection rates as between E and W sides.

TABLE 17-7
Injection Wellhead Pressure for 4-Inch Tubing

Length of tubing, ft	10,600		
Injection temperature, °F	200		
Average compressibility factor	1.00		
Gas gravity	0.585		
$S=375(1.06)(0.585)/660$	0.352		
e^S	1.422		
$15.1/D^{5.23}$	0.0113		
$R=0.0113(660Q)^2$	$0.00492Q^2$		
Million/day/well	30	40	50
$F=0.031Q$	0.930	1.240	1.550
P^2_b	22.646	22.956	23.266
P_b, psia	4759	4792	4825
Buildup, psi	99	132	165
R	4.428	7.872	12.300
$R(e^S-1)$	1.869	3.322	5.190
$E=F+R(e^S-1)$	2.799	4.562	6.740
$P^2_w e^S = 21.716+E$	24.515	26.278	28.456
P^2_w	17.239	18.479	20.010
Estimated P_w, psia	4150	4300	4480

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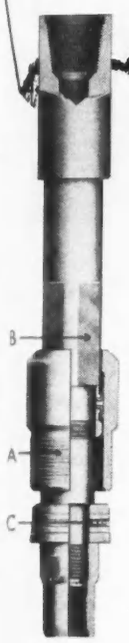
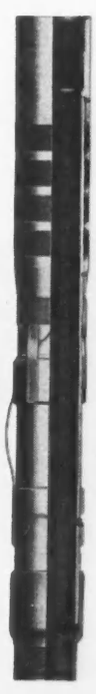


Regular Action EQUIPMENT

In this type of action, the Hanger or Adapter is supported by the coarse releasing thread of the "floating head" (A) on the Releasing Tool (see illustration at left). This floating head is rotated by the squared section (B), but is free to move up and down to prevent any "bind" being placed on the releasing thread during disengagement. When run in the hole, the ball bearing thrust washer (C) rests on a shoulder in the Adapter (or Hanger), thus providing a means of placing weight downward on the liner to hold it in place while the Releasing Tool is disengaged at the back-off thread.

The entire releasing action is unusually simple and foolproof. For example, when a Liner Hanger is used, the Hanger slips are first set by rotating the string to the left one or two turns to release the slips, whereupon lowering the weight wedges the slips firmly in place to support the liner. After pack-off operations (if any) are completed, release from the liner assembly is effected by simply applying 2 to 3 points of weight downwardly to hold the liner firmly in place, then rotating the string approximately 20 turns to the *right*. Since the back-off thread "floats" on the mandrel, it is free to move up or down to maintain perfect alignment while being disengaged—*and is completely unaffected by the weight being placed on the liner to hold it from moving*. Release is quick, positive!

Baash-Ross Security Regular Action Packing Type Adapter.

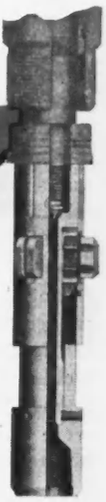


Baash-Ross Security Regular Action Packing Type Liner Hanger.

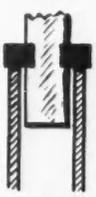
Other "Regular Action" equipment includes Plain Type Adapters and Plain Type Liner Hangers.

On all Packing Type Adapters and Liner Hangers special lock slips between body of packer and setting sleeve hold the packing element in expanded position after setting to insure a *permanent* leak-proof pack-off. Also, a choice of synthetic rubber or lead packing is available.

Delayed Action EQUIPMENT



Lugs Compressed

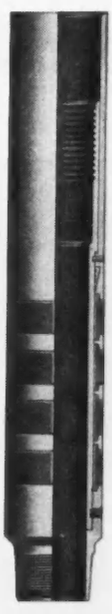


Lugs Expanded

"Delayed Action" equipment has the added advantage that the packing unit cannot be set prematurely by striking bridges or tight spots in the well—nor can it be set inadvertently by lowering too much weight against the tool while expanding the slips.

The equipment is run with a Delayed Action Packer Setting Tool attached to the bottom of the Releasing Tool (see right). This Delayed Action device has lugs that remain contracted within the setting sleeve of the packing unit (see sketch) until *after* the releasing thread has been disengaged.

The Adapter or Liner Hanger is set in the same manner as described at left for "Regular Action" equipment, and the Releasing Tool is also disengaged in the same manner—but is released *before* the packing element is expanded. To set the pack-off unit, the released run-in string is raised 4 to 6 feet to permit the lugs to expand. Then when weight is lowered back down, the expanded lugs seat against the top of the setting sleeve and compress the packing unit. The entire action is foolproof—and gives complete protection against premature pack-off!



Baash-Ross Security Delayed Action Packing Type Adapter.

Baash-Ross Security Delayed Action Packing Type Liner Hanger.

In both the Packing Type Adapter and Liner Hanger illustrated above, special lock slips between body of packer and setting sleeve hold the packing element in the expanded position after setting. This feature assures a *permanent* leak-proof pack-off. Also, both types of equipment are available in choice of synthetic rubber or lead packing units to meet varying operating requirements.

**Manufactured under license from Security Engineering*

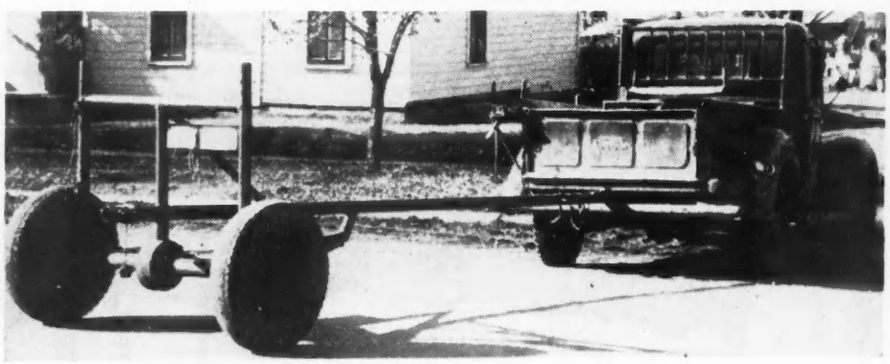
Baash-Ross Security Adapters, Liner Hangers and Releasing Tools are available through leading supply stores

How to do it! PRODUCTION HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Haul 20-Foot Joints of Pipe on a Pickup

The problem of hauling 20-foot joints of pipe with a pickup truck was solved by a trailer with an elevated rectangular frame for supporting the rear end of the pipe load at an elevation of a few inches above the upper edges of the truck box. The trailer is used in conjunction with a demountable front bolster supported on a rectangular welded pipe frame which sits on the floor of the truck box.



The wheel assembly of the trailer consists of the wheels, axles, and differential and axle housings of a discarded automobile. The load support is fabricated from pieces of three-inch pipe welded together to form an H shaped frame. The bottom ends of the H frame were welded to the top of the outer ends of the axle housings.

In order that the trailer tongue would be approximately horizontal when connected to the trailer-hitch at the rear of the truck, a four-inch length of three-inch pipe was welded to the top of the differential housing. Its top end was notched to form a saddle. Into this saddle-notch the rear end of the trailer inch pipe, cut and notched at each end tongue was welded. A piece of three—with notches crosswise to each other—was fitted and welded in place between the top side of the trailer tongue and the under side of the horizontal load supporting member, thus forming a center supporting column for the H frame.

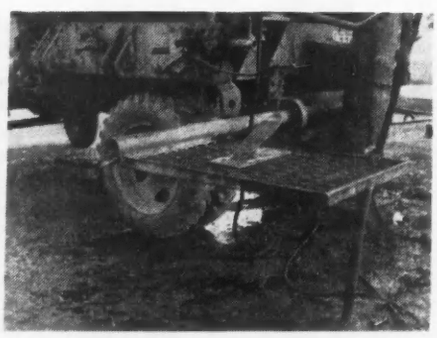
To the front end of the wish-bone or radius rod, a short length of three-inch pipe with a 45-degree bend in its mid-length section was welded. The front end of this piece was welded to the under side of the trailer tongue.

Further rigidity is afforded by welding a diagonal brace from the elevated load supporting member to the top of the trailer tongue.

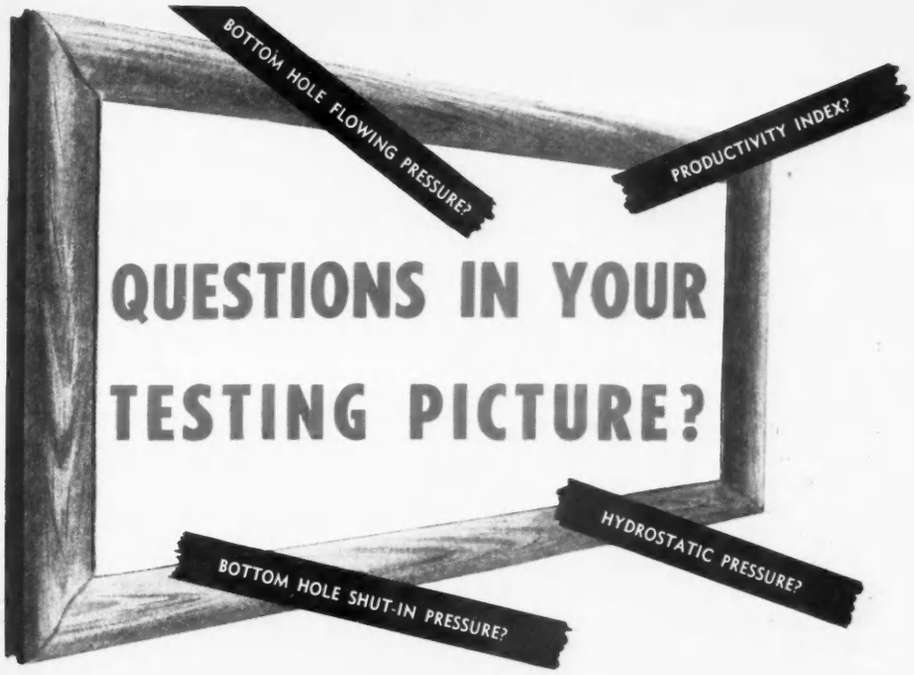
By using these accessories—a trailer with an elevated load support and a demountable truck box front bolster—20 to 30-foot joints of pipe, varying in diameter from one to 12 inches, have been transported with only a pickup truck.

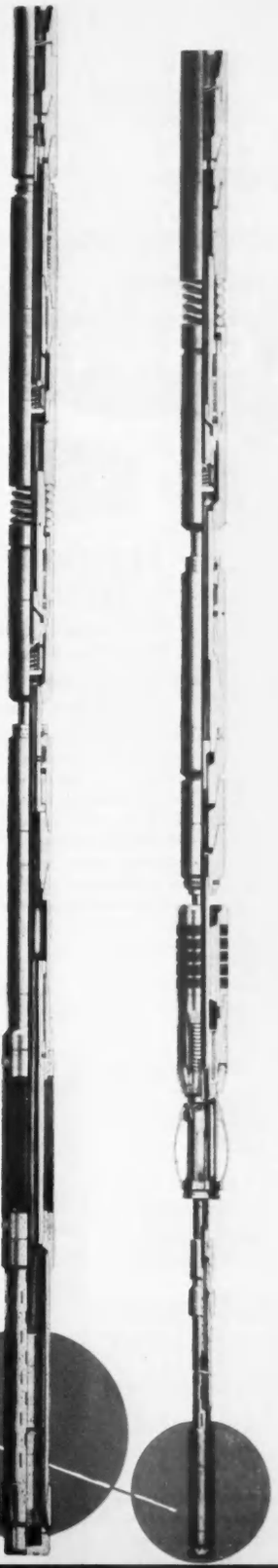
HOW TO—Build Small Unitized Well Puller's Platform

A small working platform of unique design is employed by a major company. Intended for use on jobs where the derrick floor is at ground level, at which time the well puller must have an elevated platform, the unit shown in the photograph incorporates a method of suspension that requires very little effort and time in rigging-up.



A length of four-inch pipe is run through holes in the rear ends of the truck frame members, one end of the pipe being allowed to project slightly beyond the control position. Several short lengths of three-quarter-inch pipe are welded along the length of this pipe, these matching corresponding but alternately positioned segments welded to the end of the platform. When these matching sections are placed together, a steel rod is run through them, joining the pipe and platform together in piano-hinge fashion. The other end of the platform is supported by a single length of two-inch pipe, this leg being adjustable to compensate for slightly irregular terrain. The expanded metal covered unit is easily assembled and disassembled easily, the several pieces being stowed aboard the truck without difficulty. Simplicity of design and construction, compactness, and resulting increase in working area around the rig floor are but a few of the advantages inherent in the unit.





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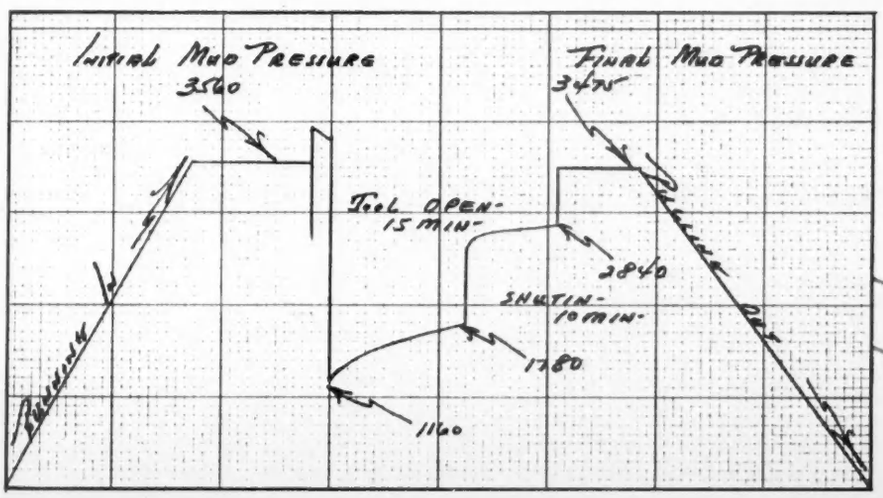

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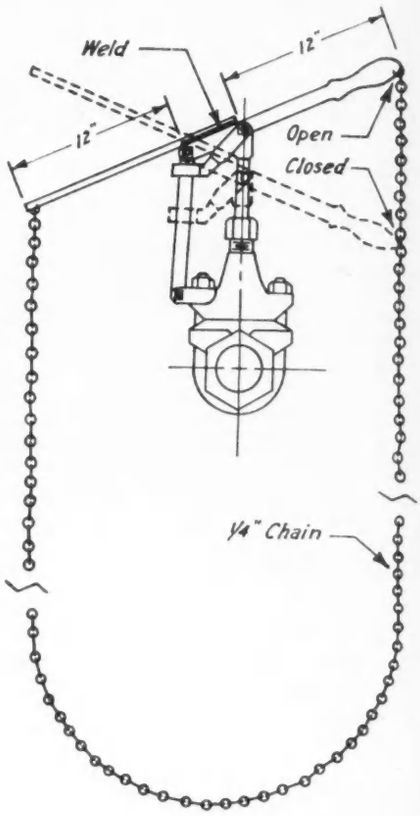
HOW TO—Make Quick-Closing Safety Vent Valve

Tank battery vent lines are frequently set on fire by lightning, and extinguishing the flame involves shutting off the flow of vent gas from the battery before considerable damage is done. To quickly extinguish such fires from a safe distance below on the ground, a quick-closing gate valve may be rigged as illustrated.

A piece of ¼x¾-inch strap iron is welded to the valve handle as shown. The end of a section of ¼-inch chain is fastened to the outer end of this bar extension, and the other end of the chain is attached to the original valve handle. The chain must be long enough to drop to a height about six feet above ground below the vent line. The open and closed position of the valve is visibly indicated at all times, and the location of the chain pulls make it possible for the pumper or others to operate the valve from the ground a safe distance from the exhaust end of the vent line.

If a quick-closing valve is not available, a regular screw gate valve may be used by machining off the threads on the valve stem so that the stem will be free to slide vertically. Support of the handle may be provided by a similar means as that indicated in the illustration.

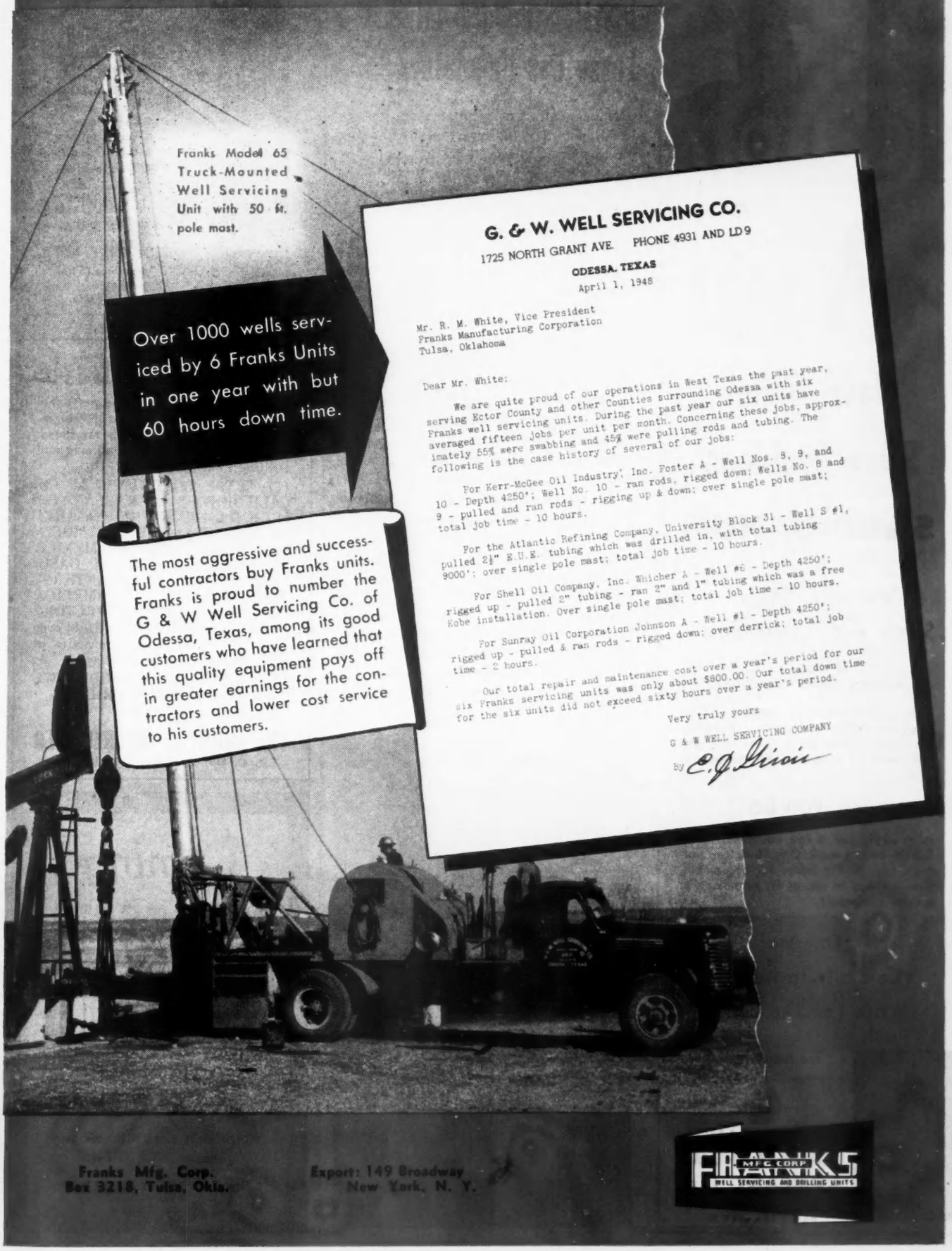


HOW TO—Build Adjustable Stuffing Box Lubricator

A shop-made polished rod lubricator adaptable to practically any height or type of stuffing box is pictured. A small cup with a hinged cover, which is filled with light engine oil, is mounted on an upright standard located beside the tubing head. The flexible copper tubing, which carries the lubricant over to the stuffing box, projects up through the bottom of the cup. A short wick, dipped into the oil, delivers the lubricant, drop by drop, into the open end of the copper tubing. Experience will determine the size of wick necessary to deliver the proper quantity and rate of flow of oil into the stuffing box.

The supporting standard is a short length of pipe to which, on the lower end, is attached a collar which may be clamped around any convenient lead line or casing fitting. The cup is clamped in a bracket which can be moved up or down the standard to obtain the desired height above the stuffing box.

You Can Judge a ~~Man~~ Contractor by the ~~Company He Keeps~~ Equipment he Buys



Franks Model 65 Truck-Mounted Well Servicing Unit with 50 ft. pole mast.

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April 1, 1948

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Franks Manufacturing Corporation
Tulsa, Oklahoma

Dear Mr. White:

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For Kerr-McGee Oil Industry, Inc. Foster A - Well Nos. 8, 9, and 10 - Depth 4250'; Well No. 10 - ran rods, rigged down; Wells No. 8 and 9 - pulled and ran rods - rigging up & down; over single pole mast; total job time - 10 hours.

For the Atlantic Refining Company, University Block 31 - Well S #1, pulled 2½" E.U.E. tubing which was drilled in, with total tubing 9000'; over single pole mast; total job time - 10 hours.

For Shell Oil Company, Inc. Whicher A - Well #6 - Depth 4250'; rigged up - pulled 2" tubing - ran 2" and 1" tubing which was a free Kobe installation. Over single pole mast; total job time - 10 hours.

For Sunray Oil Corporation Johnson A - Well #1 - Depth 4250'; rigged up - pulled & ran rods - rigged down; over derrick; total job time - 2 hours.

Our total repair and maintenance cost over a year's period for our six Franks servicing units was only about $800.00. Our total down time for the six units did not exceed sixty hours over a year's period.

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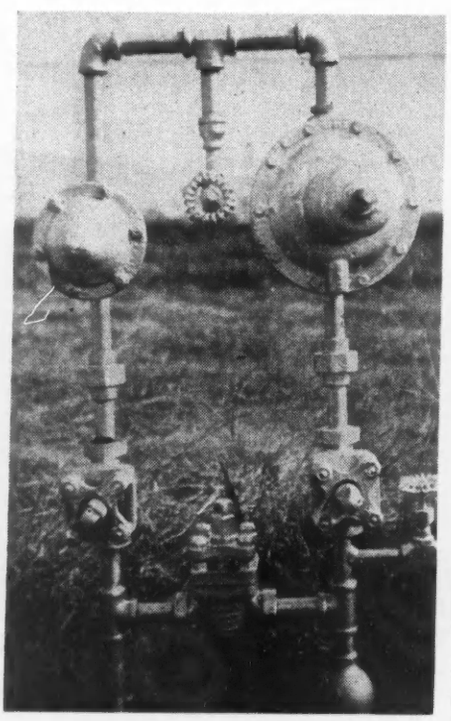
HOW TO—

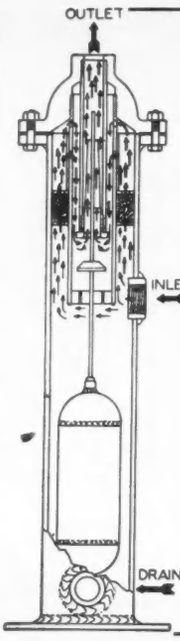
Install Standardized Lease Gas Regulators

A neat, efficient regulator station for lease fuel may be arranged by making up the assembly in the shop, with the connection for every lease made in the same manner so that the material required, labor of installing, method of maintenance is the same in every case. Separate assemblies may be kept in the shop and if either regulator fails, the new assembly may be installed in a matter of moments, and the line put back into service.

In the installation shown, the high pressure side is to the left and is tapped to the service line. Using ¾-inch connections, the high pressure regulator is installed on the upstream side of a bleed-off valve and the low pressure regulator is installed on the right to reduce the pressure for lease use.

All valves and connections are above ground level so that they can be painted to prevent corrosion and anyone can understand the hook-up at a glance. A by-pass valve is also above the ground so that a small amount of gas can be passed through the line while the regulators are being changed. A valve is provided for a pressure gauge and relief valve which is installed to check the regulators and allow manual operation of the by-pass valve.





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HOW TO—

Group Manifold Controls

Gas under relatively low pressures has many uses around the average lease to power auxiliary equipment in conjunction with the production of oil and gas. One particularly efficient tank battery having a 1000-barrel "gun barrel" tank and four 500-barrel stock tanks exploited the use of separator gas for every possible application.

Gas was used to power the centrifugal "shake out" in determining bottom sediment and water content, to operate the chemical feeder pump, to power the fire wall reciprocating pump, to "roll" the stock tanks for cleaning, and to reduce foaming of oil in the gun barrel flume.

The controls for all uses of the lease gas were grouped at one manifold to ease the pumper's job as well as provide him with a simplified system. The control manifold is illustrated, showing five vertical lines connected to the manifold through one-inch lines and valves. Gas is furnished through the middle line which taps on to the gas line from the lease separator.

The riser at the far right on the manifold supplies the chemical feeder with gas pressure, while the next line supplies gas to "roll" or churn the stock tanks. The third line is the gas supply line, and the one next to it furnishes a small amount of gas into the gun barrel flume to reduce the foaming of oil. The last line to the left supplies gas pressure to both the centrifuge and to the firewall pump.

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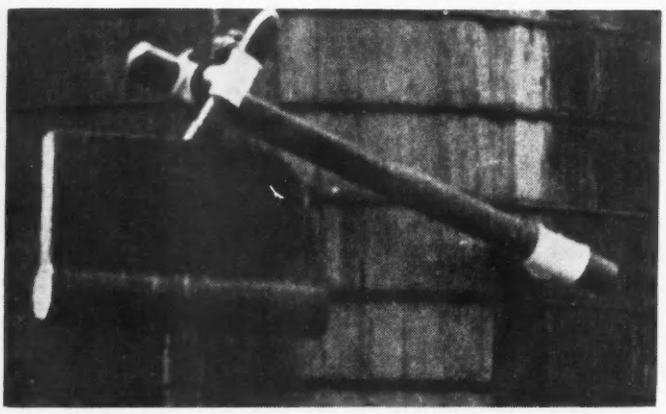
HOW TO—Adjust Fluid Level in Tank by Altering Height of Overflow Line

The fluid level in a tank may be adjusted by altering the height of the overflow line. A relatively simple hook-up which provides adjustment of fluid height in the tank over a range of two or three feet and requiring a minimum of piping is illustrated.



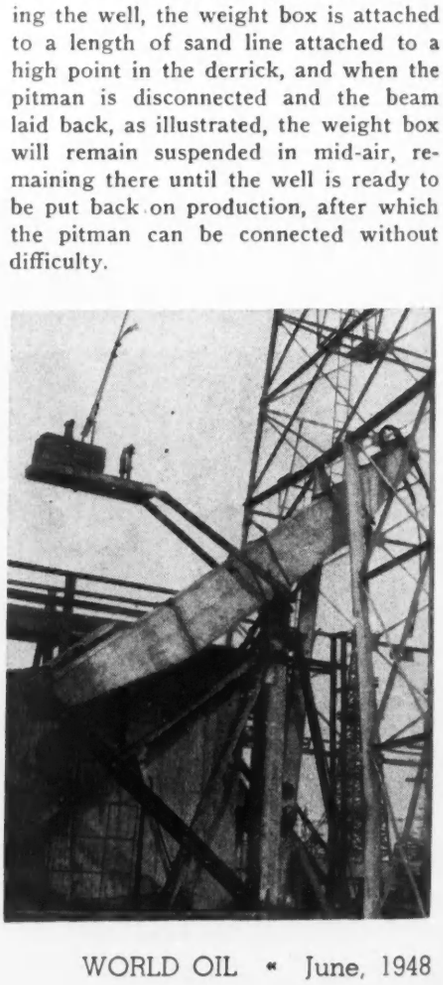
A flange attached to the tank at the desired level is fitted with a close nipple. In the case shown, size of pipe was two-inch. A tee or elbow was then attached and a section of pipe approximately 30 inches long was added as the adjusting arm. Another tee was screwed into adjusting arm, a close nipple added and a third tee screwed onto the assembly to form the discharge nozzle which is approximately 14 inches long.

An elevated tray made from a two-foot section of four-inch casing was capped on both ends, and slotted down the top providing an opening about 2½ inches wide. A sheet metal bonnet was welded around the slotted opening as shown so that the discharge nozzle may be adjusted within the bonnet as different fluid levels are desired. A drain hole was cut in the tray to which was welded a short nipple to accept a coupling that was connected to the drain line leading to the overflow sump. A small wire tied to the upper end of the adjusting arm secures the overflow line at the desired height. It is attached to the top of the tank.

HOW TO—Support Counterweights

On many standard-end types of pumping units, counterweights frequently are attached to the back end of the walking beam. However, when the well is pulled, the necessity of having to lift and maneuver the weighted end of the beam while the pitman is being disconnected and re-connected imposes considerable extra work on the crew.

To overcome this frequently re-occurring problem, a slightly different method of attaching weights can be resorted to. Instead of mounting the unit permanently to the end of the beam, they are attached to a flat steel pan or shallow box, the latter connected to the beam by means of two strap iron arms which extend forward to be attached to either side of the saddle bearing. Prior to pulling the well, the weight box is attached to a length of sand line attached to a high point in the derrick, and when the pitman is disconnected and the beam laid back, as illustrated, the weight box will remain suspended in mid-air, remaining there until the well is ready to be put back on production, after which the pitman can be connected without difficulty.



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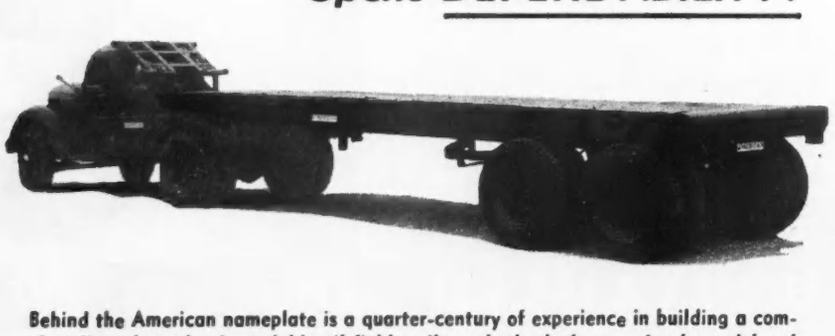

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EXPANDED SYSTEM OF Great Lakes Pipe Line Company

AN EXPANSION program to meet needs anticipated by 1950 was put through on this pipe line in little more than two years against postwar material shortages by careful planning and scheduling of work. Temporary metal structures, put up to give immediate use to stations, sheltered permanent construction, enabling winter months to be utilized for work normally seasonal. Special manifolds speed deliveries and withdrawals and prevent commingling losses.

EXPANSION and modernization of the Great Lakes Pipe Line Company's system, involving approximately $30 million, stepped up total capacity of the line by 50 percent. New daily throughput capacity is 104,600 barrels, with a total mileage of 3,134.96, almost entirely of six- and eight-inch pipe. Three eight-inch mains carry the line from Barnsdall Okla., to Kansas City, with two eight-inch lines north to Des Moines, where one six-inch line runs to Chicago, paired sixes to Minneapolis. A third eight-inch line extends from the Kansas City station to Alexandria, Minn., continuing as six-inch to Grand Forks, N. D. Other branch lines bring up the mileage to the total cited.

The total program involved the laying of more than 1200 miles of lines, construction of 14 new primary pump stations, eight new delivery terminals, the remodeling of the buildings and facilities at 14 existing pump stations, and two terminals on lines from Tulsa to Minneapolis. (A map of the enlarged system appears on Page 186, WORLD OIL for March, 1948).

Major portion of the line construction was in the projection of a new route from Kansas City northwest with terminals at Omaha; Sioux City, Iowa; Sioux Falls and Watertown, S. D.; Alexandria, Minn.; and Fargo and Grand Forks, N. D. All these are new with the exception of Omaha, formerly served by a line from Osceola, Iowa. Grand Forks, the northern end of the line, is 65 miles from the Canadian border.

In addition, two other terminals were constructed; one on existing lines at Mason City, Iowa, and the other at Mankato, Minn., from a connecting line to Albert Lea.

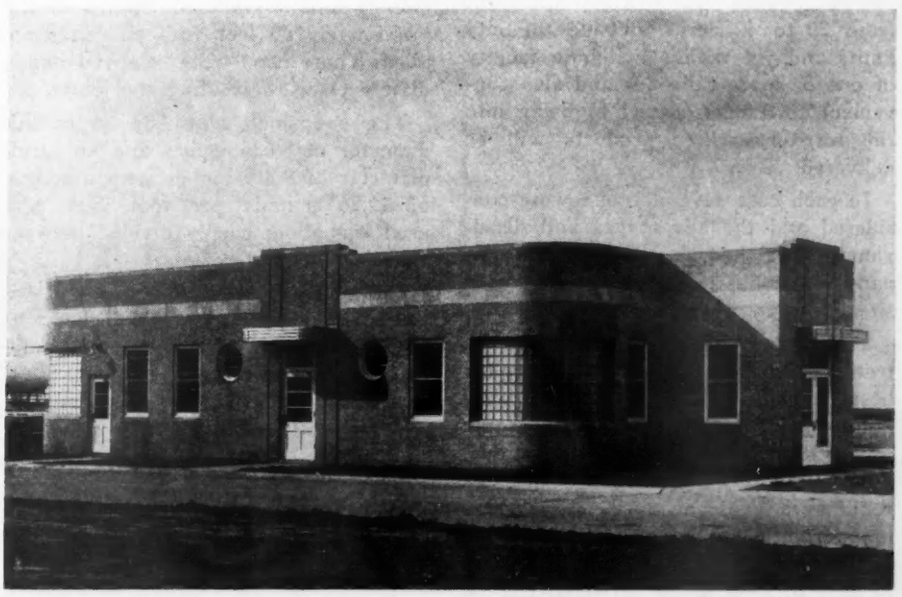
An understanding of the motive or goal of the construction program is helped by a knowledge of the company's operations. Unlike many other pipe line companies which operate as common carriers, it has a relatively large number of points of origin of shipments. At present it is receiving through its own lines from 19 refineries at Oklahoma and Kansas towns, and from a line owned jointly by Sunray Oil Corporation at Allen, and H. F. Wilcox Oil and Gas Company at Bristow, to Drumright, Okla., where it joins a Great Lakes line. An interchange agreement with Phillips Petroleum Company, Products Pipe Line division, adds two more refineries at Borger, Texas.

Products Moved Quickly

Few of these refineries have large storage facilities, which means that Great Lakes has to move the shipments as soon as possible after they become available. This is in contrast to the practice of some companies which are able to have the products pumped to a central point for pipe line shipment as line space becomes available.

All of the terminals to which Great Lakes lines are connected are owned by it and the company is responsible for each shipment until the product is loaded into motor transport or tank car for jobber distribution. This, too, is in contrast to pipe line companies which deliver to terminals owned by a distributing company, where the moment a shipment enters the terminal it becomes the property of another company.

With a large number of shippers there is a proportionate demand for the handling of more grades of products and for a smaller minimum shipment barrelage with consequent task of segregation, both in movement and in handling at terminals. To solve this problem as efficiently as possible is the purpose back of the designs which have for their basis the maximum handling of nine different grades. The ultimate achievement in this respect is the new transport loading machine where the operator has at his



Appearance is combined with utility in the new virtually maintenance-free buildings. The terminal service buildings and the pump stations are similar and at the terminals buildings harmonize as a group.

finger tips immediate control over the loading of nine grades of products.

In order to get the needed flexibility, many of the improvements, especially at terminals, necessitated a larger initial investment than an alternate plan would have, but measured by a period of years the plan used is definitely less costly and is, of course, more efficient in daily operation.

During the planning stage shippers were asked to make an estimate of their transportation needs in the areas that would be served by the enlarged system. Based on these forecasts, the capacity was set at a figure which it was indicated would take at least five years to reach. By the summer of 1947 Great Lakes was moving that amount of traffic, and before the permanent construction was completed, temporary secondary stations using adapted aircraft engines as prime movers were being built[1] to increase further the capacity of the system.

The study from which the construction program developed indicated the cities in which new terminals would be located. It was the desire of Great Lakes management to establish these points fairly close together, giving shippers an opportunity to increase the pipe line portion of shipments and decrease the distance necessary to move products by tank car or motor transport into consuming territories. Terminals on the new northwest line are approximately 100 miles apart.

Factors included in choosing a terminal site include present space requirements, room for possible expansion, and terrain. Careful attention also must be given to outbound rail and highway transportation. Obviously, it is a difficult assignment to select a property of from 20 to 40 acres, outside the city limits and yet within switching facility of one or more railroads and also convenient to a main paved highway into the territory where products will be delivered.

In each case several tracts were considered and the advantages and disadvantages weighed. At each city the company was able to acquire the favored site.

Preliminary to the construction in the territory northwest of Kansas City, the best available maps of the area were obtained. From these a general route was selected between the then known points, the terminal cities. With this route as a guide an aerial survey was made from which maps were constructed by the use of photogrammetry. Result of this process is an aerial survey on which distance, together with elevation, may be calculated directly and accurately from a photograph.

With this information before him the locating engineer proceeded to select the exact route the line would follow. Land plats giving its course through each property were prepared and supplied to the right-of-way agent.

As winter was at hand in the Northern states by the time these men started to work the weather was a factor in their daily trips. They traveled to farm homes by automobile, horse and buggy, by sleigh, and at times when roads were closed to these methods, they donned skis or snow shoes.

When the permits were obtained a ground party set stakes for the line at proper intervals to guide the contractor who had been chosen on the basis of bids made on company specifications.

River Crossings

Permission of the War Department was required for river crossings of the Missouri at Decatur, Neb., the Red river at Fargo, N. D., Minnesota river at Granite Falls, Minn., and the Kaw at Kansas City. Along the Missouri river, especially in Nebraska, large drainage canals were encountered. Wherever permission of the drainage districts could be obtained for construction of supporting towers the line was suspended over the canals. Three of these averaged 250 feet in length and it was required that the pipe have a clearance of 40 feet to permit the passage of drag lines used in cleaning the canals. Suspensions of this height necessitated careful engineering and the use of heavy supporting towers and anchor fixtures. Nevertheless, the ultimate cost of such crossings is less than putting the line underneath the water.

All pipe was received from the supplier in double random lengths of approximately 40 feet with end caps applied. These caps were removed immediately prior to welding the joints.

The eight-inch pipe has an outside diameter of 8.625 inches and an inside diameter of 8.219 inches with a weight of 18.26 pounds per foot. The pipe used was about evenly divided between electric-weld and seamless.

The six-inch pipe, all electric-weld, has an outside diameter of 6.625 inches with a wall thickness of .1875 inches and a weight of 12.89 pounds per foot.

Electric welding was used to join the pipe. After the lines were laid they were machine cleaned and a fast drying primer coat was applied. This was followed by two coats of coal tar having a total thickness of 5/32 inch, and a spiral wrap of asbestos felt completed the coating. Rectifiers supplied with purchased current were connected to the line at proper intervals to provide cathodic protection throughout the length of the new line. It was buried with a maximum of 24 inches of cover except where otherwise necessary because of crossings or other requirements. Across cultivated fields a minimum cover of 24 inches was used.

Inability to obtain pipe on any sort of schedule delayed for weeks completion of this work. On many days the distance laid was determined solely by the amount of pipe received on that day.

Gate valve boxes on the line are six feet square, five feet deep, and are made of transite, a material impervious to moisture. Couplings are attached on both the upstream and downstream sides of each valve so in event of line pressure loss its location can be traced by a process of checking pressures in successive line sections.

When the line is shut down the downstream valves are closed and a pressure reading taken by a gauge attached to the coupling. The worker then moves on to the next gauge where he takes a reading. This is done until he has covered an assigned distance. Then he returns to the original coupling and repeats his trip, taking readings at each coupling. When a section shows a decided pressure drop it is immediately investigated.

Prime movers are vertical six-cylinder, single acting, four-cycle turbo supercharged diesels which develop 810 horsepower at 600 revolutions per minute. The engine is a duplicate of those used for locomotive power. Distillate is used for fuel but a test is being made on an engine converted for use of natural gas. Great Lakes engineers say the economy of operation is attractive if the design can be made practical. The engine can be reconverted for distillate by a half-turn of a lever. This is the first attempt made to change this type of engine to natural gas fuel.

Pumps are six-stage centrifugals driven by a speed increaser at a 5.978 ratio.

Flow rates are controlled by an air bellows actuated regulator. Suction pressure is the determining factor, within certain limits. When the safety limit is reached on the discharge side, set at 50 pounds above normal operating pressure, the discharge side of the regulator takes over control of engine speed regulation, thus preventing the engine from reaching a speed which would build up pressure that likely would cause line breakage.

Heat exchangers for both the lube oil and engine coolant are located vertically underneath the floor within the building. This method obviates the necessity for draining the exchangers when not in use in extremely cold weather

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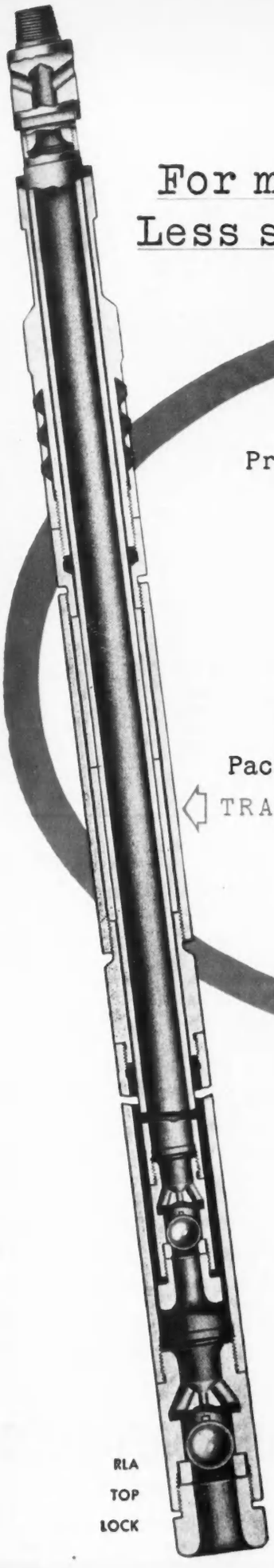

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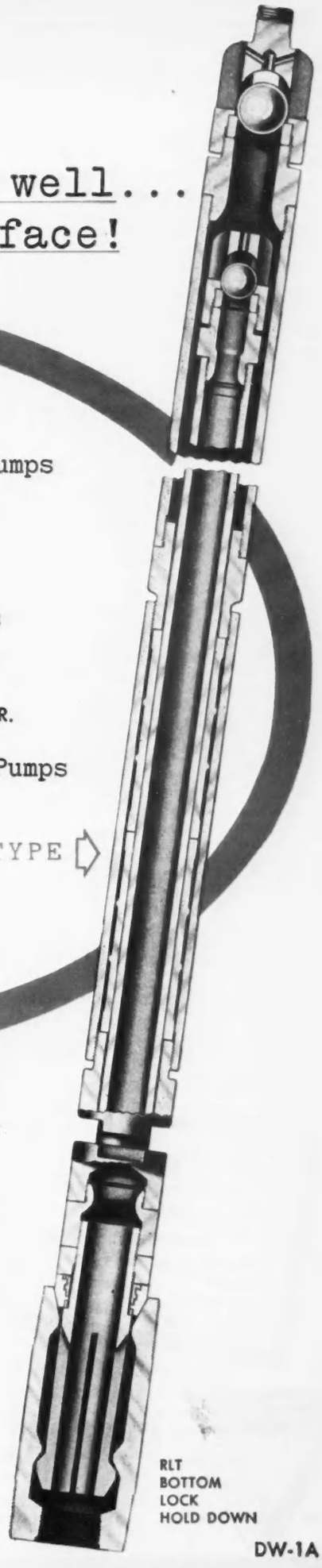
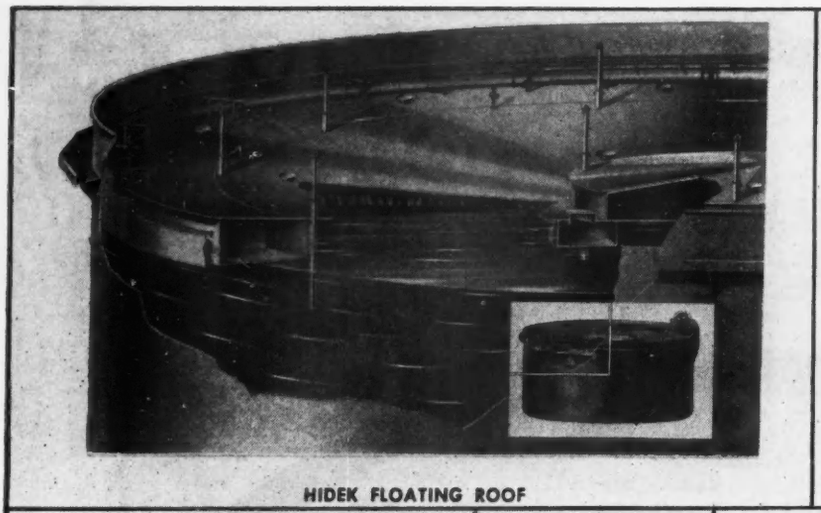


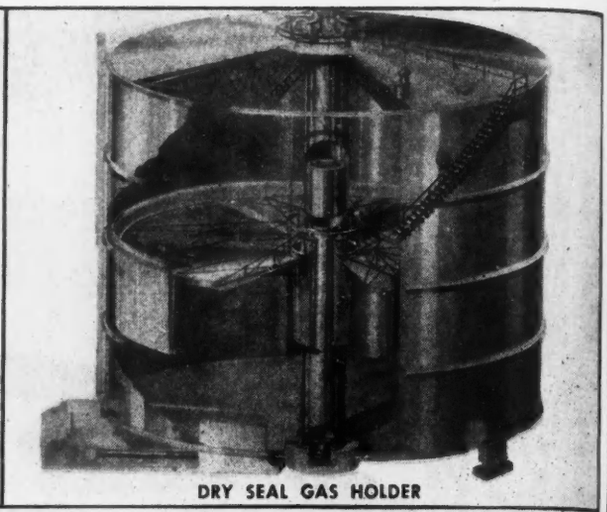
RLA
TOP
LOCK

RLT
BOTTOM
LOCK
HOLD DOWN

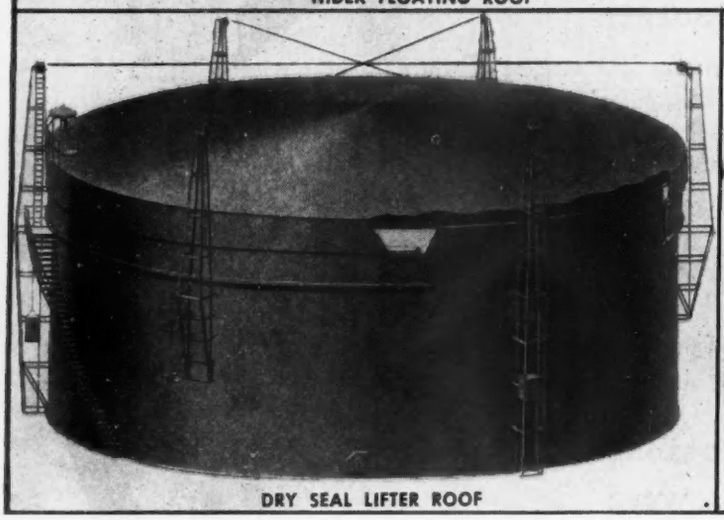
DW-1A



HIDEK FLOATING ROOF



DRY SEAL GAS HOLDER



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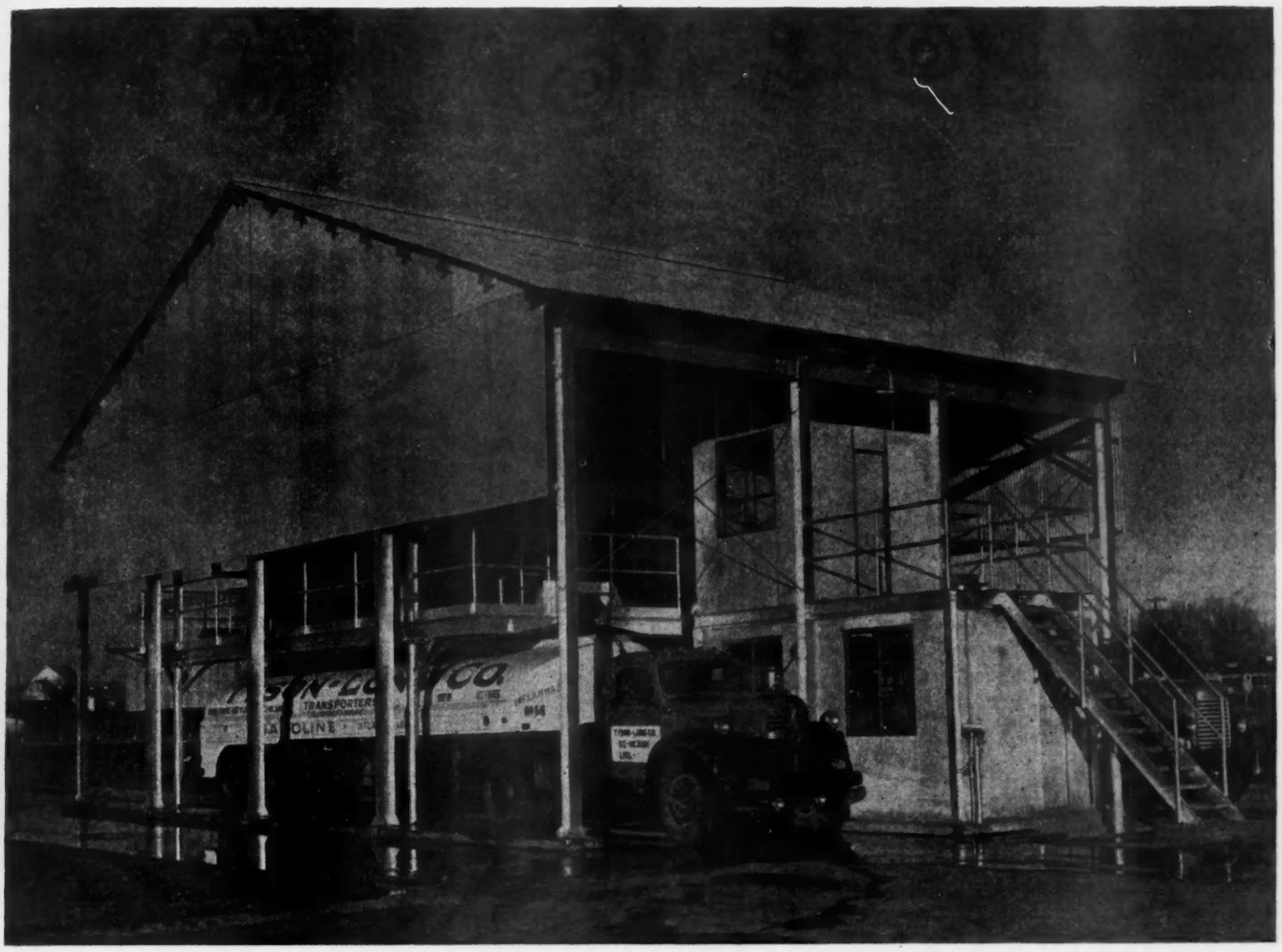


Perfectly safe loading conditions are assured the operator of the loading machine by the platform which is borne by hydraulic supports and which may be adjusted to the exact height of the transport loading domes. Controls for loading of nine different grades of products are instantly available.

and also makes for a neat appearance.

The engine heat exhaust is utilized to heat the station. Heat from the engine is transmitted to the boiler room where it generates steam and passes it through coils. A power blower feeds air across coils where it is warmed to approximately 110 degrees and carried through ducts to ceiling diffusers in the rooms that are to be heated. Air from the engine and pump rooms is taken out by power exhausters to remove all dangers of fumes.

The rooms react to heat demands through thermostat control and temperatures are maintained within one degree of the desired figures.

When the engine is not in operation, heat for the boiler is supplied by a distillate burner. When operated in this manner, the exhaust pipe of the engine is closed off from the boiler to prevent high temperature gases from going back and damaging the diesel assemblies.

Water wells at the stations are indoors. The building lights are flush mounted in the ceiling, vapor tight, and equipped with pressurizing connections. The wiring system utilizes breaker points for overloads instead of fuses.

A construction feature which has aided in maintaining comfortable floor temperatures in all buildings is a cold-break. It consists of a trench inside the foundation and under the floor a foot wide and a foot deep filled with asphalt.

All buildings are of tan brick and tile construction. Ceilings are of off-color white-paneled acoustic material which helps to reduce the noise level of the rooms. Machinery is painted stratosphere blue. Tile floor of rust color and a narrow green horizontal wall stripe against the peach walls four feet up and chocolate-colored cove base tile combine to give the interior a pleasing appearance, make housekeeping easier, and greatly lessen maintenance.

Auxiliary equipment includes an air compressor, a generator where purchased electric power is not available, and a water well pump. Yards are graded and landscaped and the entire area enclosed with a chain link fence.

Design of the new terminals represents a decided improvement as compared with former facilities. From an adjoining paved highway, Great Lakes has built two concrete roads leading to the transport loading machine. Nearby is the tank car loading rack. Between the two lines of traffic is a building of brick and tile, 65 feet long and 30 feet wide, which houses the office, laboratory, heating plant and store room.

In the completely equipped laboratory a chemist makes tests on incoming shipments aand again before the products are loaded out. The electric gauging dial in the office provides a means by which a reading may be taken instantly of any tank on the farm, correct to within one-eighth inch.

The walls and floors of these buildings are tile construction and the ceiling of acoustic material to reduce maintenance to a minimum. The heating system is thermostatically controlled.

Steam is produced in the boiler house and in winter piped under pressure to the loading racks for thawing outlet caps and dome covers on motor truck transports and railway tank cars.

The tank farm and delivery system gain interest both by the facilities they have and also by much they do not have. In the latter category, they do not have an imposing maze of complex equipment at a central pump house, the piping is not an intricate weave of crossovers, switches and numerous valves.

Simplicity is the keynote of the new arrangement. Each tank is a separate

unit complete in itself, having its own receiving and delivery lines, transfer pump and circulating system. With these facilities it is able to perform four functions: receive, circulate, blend and load, without interfering whatsoever with any other tank.

This system allows a tank changeover from one product to another to be made easily and quickly by the operating crew. Under the former method it was necessary for a special group to revamp the tank piping and pump connections, an expensive procedure in both time and money.

In case of heavy demands for a product, two or more tanks may be connected to common delivery facilities within five to ten minutes. The extreme flexibility of the system is illustrated by the 3802 two-tank combination hookups possible at a 20-tank farm.

Having individual pumps at each tank also has done away with the vapor locks which prevailed at some of the gravity feed delivery systems.

Transfer of incoming products from the main line is accomplished by connecting the swing line of a cartwheel arrangement in the products segregator room of the pump building to the tank's receiving line. Delivery from a tank to any common carrier is made by changing a nipple at the loading manifold. As all lines are above ground the product flow can be traced quickly and easily. The elimination of manifolds prevents contamination and carries on the basic idea of the entire system of making connections as short coupled as possible.

Each tank has a separate circulating system, but where tetraethyl lead is introduced into all tanks it is done by a common line. The lead tank is housed in a separate building which has on one end a room containing the dye pot from which dye is introduced into the gasoline. The brief time necessary to induct the lead and dye is the only period the common line is tied up. After these have been introduced the tank is circulated. With the new design tank spider is a small hydraulic pump which greatly speeds up the operation. The circulation for any tank is completed within 30 minutes.

The tanks are cone roof, connected with lifter roof tanks in a vapor recovery system. As many of the terminals are in regions where ice, sleet, and snow are commonplace in winter, the lifter roof type tank is preferred. Low vapor products are handled in the cone roof tanks without vapor recovery connections.

Inside the tank, the upper half of the suction line for withdrawing products is cut away to provide a trough. Because all the product has to enter the suction line from the top, water on the bottom of the tank is prevented from entering the loading system.

The water pump is located at the lowest place on the bottom of the tank and prevents the loss of product by eliminating a vortex formation during the withdrawal of winter.

Tank gaugers carry a magnetic telephone set and may if they desire plug in at a connection at each tank. The tank top has vent and vacuum valves for over pressure and to prevent vacuum collapse. Each unit is grounded against lightning. Tanks are enclosed within firewalls of 100,000 barrels capacity, equal to or greater than the barrelage of the tanks which they enclose. Tanks are covered with a high luster chalking paint which retains a slight amount of moisture, tending to have a self-cleaning effect.

Improved Loading Facilities

The new loading machine for motor transports is probably the most complete in existence and represents the greatest improvement over conventional design of any facility on the system. It was developed to correct the bad features of loading racks formerly used by affording safety for the operator and by increasing the speed of loading.

Its center of operation is a series of pantograph piping which may be moved up and down and back and forth to reach transport domes of motor carriers. To prevent the pipes from twisting out of position they are restrained by a six-pulley trolley which is guided in its travel by sets of beams. The group somewhat resembles in appearance the adjustable extension of an industrial extension telephone.

The loading platform rests on hydraulic plungers installed beneath the roadway. When a transport pulls into a loading stall the platform is at its highest position. The operator presses a button, lowering the platform to a level with the top of the transport, where he can move in all directions with perfect safety. He removes the dome covers, pulls the pantograph into position, and attaches the downspouts. Back on the fixed platform he adjusts the set stops, inserts the bill of lading into the automatic printer which registers the gallonage, and starts the flow of products.

The set-stop cuts off the flow at the predetermined level, the loader removes the downspouts, seals the dome of the truck compartment, and removes the bill of lading from the printer. Then, with a push of the button, up goes the loading platform and the transport is cleared for departure.

The operator can start and stop the electric pumps at any of the tanks from the fixed platform.

The tank car loading rack and the motor transport loading machine are interlocked both hydraulically and electrically, but the electric control panel at each point operates separate relays. This provision is to take care of the pump motor stops and starts when both are loading from the same tank. The first operator to push the start button closes the pump contact switch and starts the pump; the last one to push the stop button releases the switch. This arrangement prevents one operator from stopping the pump when the other has not completed his loading operation.

Possibility of damage from the unavoidable contraction and expansion of pipe runs has been eliminated by using long gradual pipe bends at appropriate positions.

In the modernization program of existing line, the problems were much the same as those on the new route with the exception that there were fewer right-of-way easements to be obtained and fewer terminal sites to locate. One of the big obstacles was at pump stations where the work had to be carried on without disrupting normal operations.

A third eight-inch line was laid on the 204-mile route from Barnsdall, Okla., to Kansas City and a new 85.76-mile line was laid to this section at the Humboldt station, from refineries at El Dorado, Kansas. Between Ponca City and Barnsdall two six-inch lines were replaced with an eight-inch line. The six-inch pipe in the No. 2 Tulsa-Barnsdall line was replaced with eight-inch. These changes provided lines with matching capacities between these points and the Barnsdall-Kansas City lines.

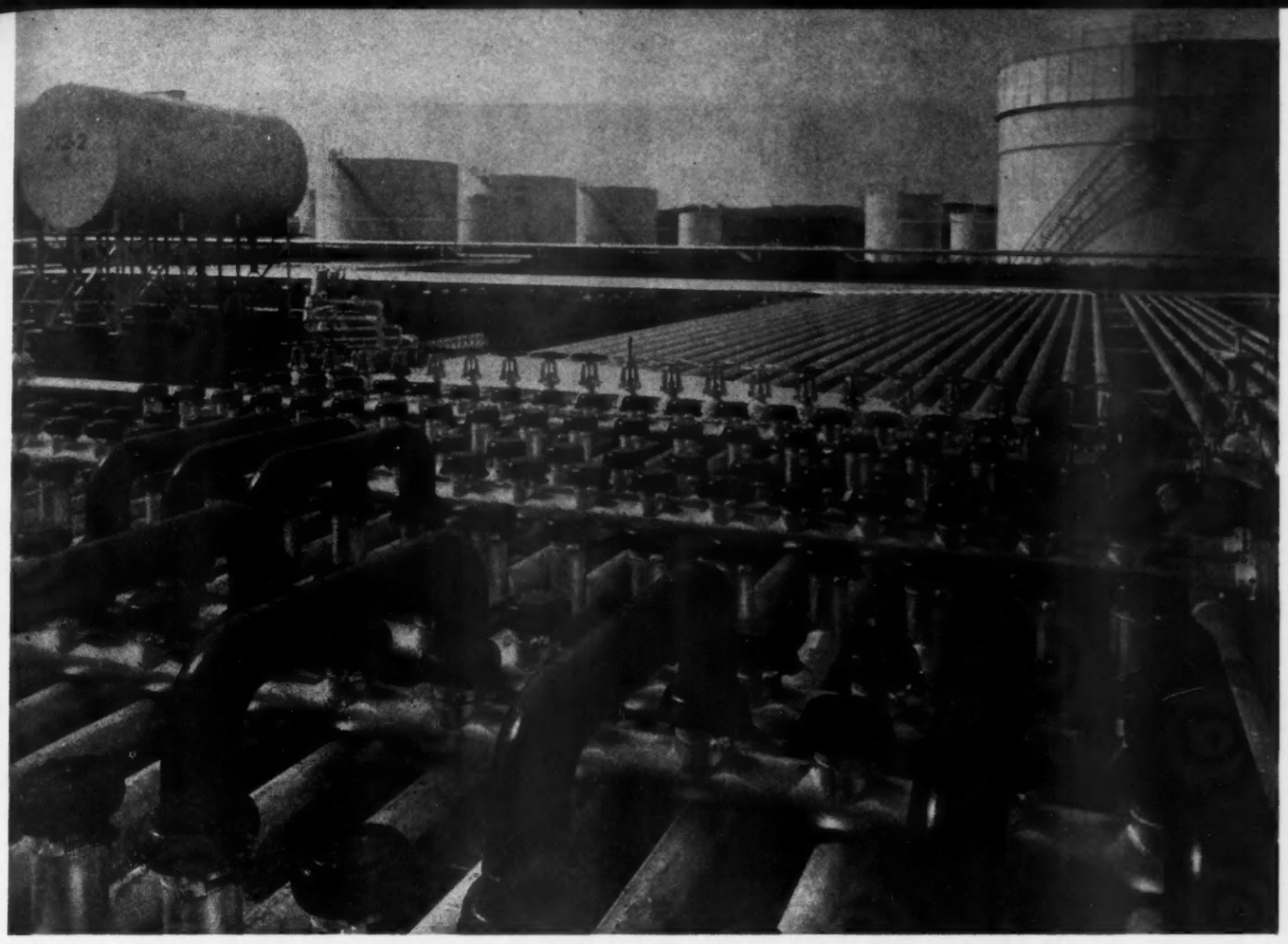
At primary stations north and south of Kansas City the former policy had been to use two units for each line, with each unit supplying half the pumping capacity. In nearly each case the unit had consisted of a reciprocating pump driven by a diesel engine.

The new policy carried out in the modernization was to replace these units with a single centrifugal pump driven by the same model diesel used on the new line. This meant that the number of pumps and engines at each station was halved. At the Kansas City station three electric units were installed.

The former method of underground tank lines at terminals and transfer points also was abandoned and they were brought above ground. The old type incoming manifold was replaced with the simple cartwheel arrangement.

Installation of these new units and pipe arrangements achieved the same result as on the new lines, greatly reducing the commingling of products and increasing the ease and flexibility of their segregation in handling.

Not only were the equipment and fa-



Segregation of products and flexibility of tankage is accomplished by the loading manifold with its swing arrangement. Individual pipes to each tank make it a separate unit and permits rapid reconversion to different products when desired.

cilities modernized, but also the buildings. Interiors of the stations were completely remodeled. New tile floors were laid and ceilings were replaced with acoustic panel material which is continued down the walls to within seven feet of the floor. There it joins a seven-foot tile dado which is topped with an aluminum horizontal stripe above a green tile stripe at the four-foot level. These changes give the stations the benefits of the latest type construction with its reduced maintenance and better appearance.

A program such as this even in normal times is an enormous undertaking. During the period in which it was carried on it assumed the proportions of a battle. There were several factors which helped to account for its successful conclusion.

The first was getting an early start. Materials and machinery were ordered as rapidly as requirements were determined. An investigation of building material available showed that no matter what was chosen its procurement would be a problem. Experience has proven that a brick and tile combination provided an excellent building, and it was decided not to lower company standards by accepting anything inferior.

The management gave orders to ship all material as soon as it became available, no matter what is was. Wire, nails, screws and numerous small items that ordinarily never would have been stored were taken as soon as they could be obtained and stocked in warehouses along the line from Oklahoma to the Canadian border. The wisdom of this course was proved many times; in one instance nails disappeared from the market. The saving in time of construction was tremendous.

Another innovation in building procedure allowed the new line to be placed in operation months earlier than otherwise wouldl have been possible. Several temporary steel buildings were purchased and erected on the permanent buildings sites. This was done so that if permanent construction became impossible and pumps and engines arrived operations could be carried on under these shelters temporarily.

As pumps and engines were received they were set and put in operation in these temporary buildings which were considerably larger than the permanent structures. When materials arrived construction progressed under the temporary buildings. This had still another advantage. Bricklayers were able to work under protection from the elements. In the Northern states this was especially advantageous as they were able to remain in their home town rather than having to go south to work during the winter.

As soon as the roof and walls of the permanent buildings were completed the temporary structures were taken down and moved to another location. In these communities people were treated to amazing one-day transformations. Driving by a Great Lakes station in the morning they would see the usual metal building. By evening a modern brick building had appeared in its place.

While this procedure permitted line operation it meant that station personnel had to work under conditions similar to what a family would undergo if it were to move into a residence as soon as the walls and roof were constructed and the floor in one room partly laid.

It was in this manner that the system operated for months at an enlarged capacity, moving millions of barrels of products to an area that was constantly demanding more gasoline, more distillate, more fuel oils.

Hesitancy in the start of construction or a slackening of effort at any of the stages of the program would have meant a further delay of months.

Reference

[1] Keane, C. C. Surplus Airplane Engines Power Products Line Stations, World Oil, v 127, no. 12, March, 1948, p. 181.

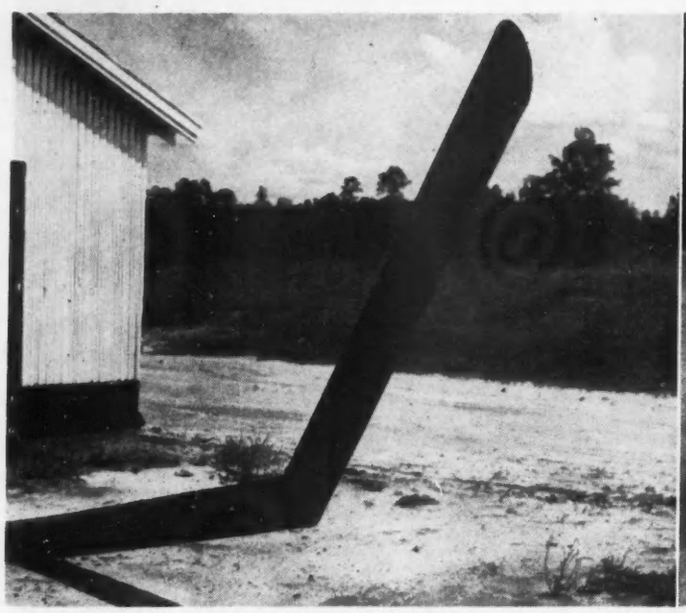


FIGURE 1. In this exhaust, changing the inclination of the last six feet of pipe with respect to the rest introduced a factor which effectively dissipated much of the gas through perforations and practically eliminated the sharp report as the slug of hot gas left the end of the pipe.

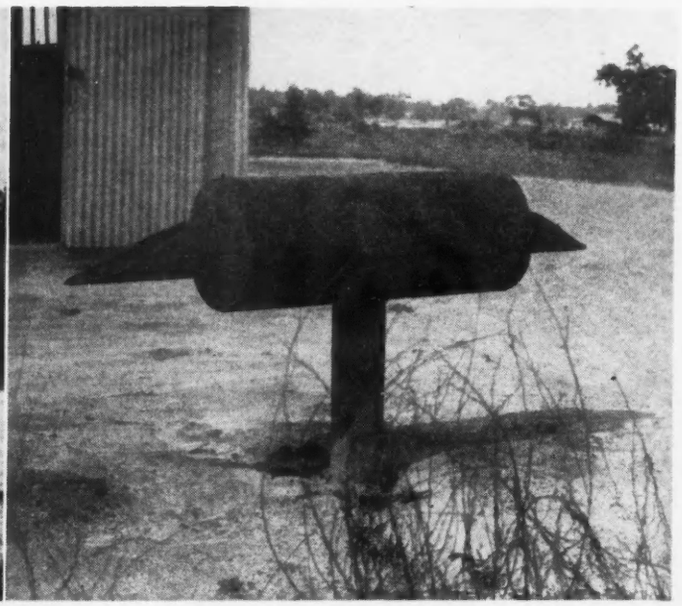


FIGURE 2. The vent pipe in this muffler extends through the shell, with perforations through the upper third of the pipe so that gas must travel around the shell before being vented through the twin ports. Upward-looking bevels reduce dust nuisance around station by deflecting gases away from ground.

Suppressing Noisy Exhausts

By M. H. PEARCE

SLOW-SPEED engines are more difficult to muffle than multi-cylinder high-speed station power units because of the relatively large amount of heated gases moving as a unit as the exhaust valve opens. Where the stations are located close to town, or a company camp is nearby, this exhaust noise sometimes becomes a serious nuisance.

Experimentation with the exhaust pipe has developed a number of methods in which the exhaust gases are gradually dissipated and the resultant noise materially reduced. One such plan utilizes a single length of pipe, of the same diameter from the engine exhaust port to the beveled end. The last four feet of the pipe are perforated with torch-cut holes, averaging one inch in diameter, but formed with rough outlines instead of smooth circles. When the exhaust pipe was simply a straight piece, at a slight angle to the ground, the exhaust pulsation was little affected by the perforations. Cutting off the last six feet of pipe, however, and welding it an an angle of 60 degrees to the remaining line changed the characteristics entirely. The gases emerging from the beveled end of the pipe were greatly reduced in pressure, while the perforations not only permitted gases to escape, but also let in air behind the faster moving slug of hot exhaust gases, preventing the sharp report when the end of the pipe was reached.

This exhaust was on a single-cylinder engine and was operated without the usual water injection, due to the need to reduce corrosion of the exhaust system as much as possible.

Drum Muffler Adaptation

An adaptation of the usual drum muffler successfully quiets the pulsations from a two-cylinder gas engine driving another small pipe line station. The exhaust line is of four-inch pipe, brought out under ground. A right-angled bend carries the riser well outside the station working area. A drum of ten-inch pipe is set across the riser, with dished ends of steel considerably thicker than the sheet forming the cylinder. A section of four-inch pipe is passed through and welded to both heads, with the section within the drum perforated to give gas passages greater in area than the four-inch main exhaust line. These perforations are in the upper half of the pipe only, so that all gases must change direction through nearly 180 degrees before entering the outlet section.

Due to the volume of the drum and the area of the perforations in the vent pipe, the drum momentarily absorbs a portion of the slug of hot gases with each exhaust, feeding the excess pressure to the outside air gradually during the interval between pulsations.

The ends of the outlet pipe are beveled from the top, instead of following customary practice and having the longest section uppermost. This tends to turn the gases slightly upward, and is effective in reducing the amount of dust which is raised when the pulsations are deflected toward the ground.

If exhausts must be mounted between buildings or in the neighborhood of tanks, the open ends of the vent pipe or pipes should be directed so as to avoid formation of echoes from surfaces perpendicular to the path of the sound waves. If this directional setting is not possible, the planting of shrubbery beyond reach of the hot gases but between exhaust outlet and possible reflecting surface will break up the sound waves and eliminate echoes. Too compact a growth, as with privet hedge, sometimes forms a sounding board and amplifies, instead of smothers, the sound of the exhaust pulsations.

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Flood-proof Scraper Traps

ANSWERING the challenge offered last July when the flooding Mississippi River broke a 103-year record, employes of Ajax Pipe Line Corporation designed and built a flood-proof scraper trap on the west bank of the river, near St. Louis, which will permit normal pipe line cleaning operations to be carried on during floods of record proportions.

The section is the Ajax crude oil pipe line between Wentzville, Mo., and a river crossing control gate on the west bank of the Mississippi River, approximately 39 miles. This is part of the Ajax double ten-inch trunk line from Glenn Pool, Okla., to Wood River, Ill.

Due to the different types of crude pumped through this line, it sometimes is necessary to run scrapers as often as twice a week to maintain maximum capacity. In the past, scrapers inserted in the line at Wentzville pump station were removed at a ground level scraper trap near the west bank control gate.

However, on July 2, 1947, the Mississippi River rose to a height of 33.92 feet, breaking the flood record which had stood since 1844, and remained at flood stage for 38 consecutive days.

Though the elevated control gate remained above water and the line continued to operate throughout the flood, scrapers could not be run for 46 days. As a result some loss in maximum capacity from Wentzville to Wood River was experienced.

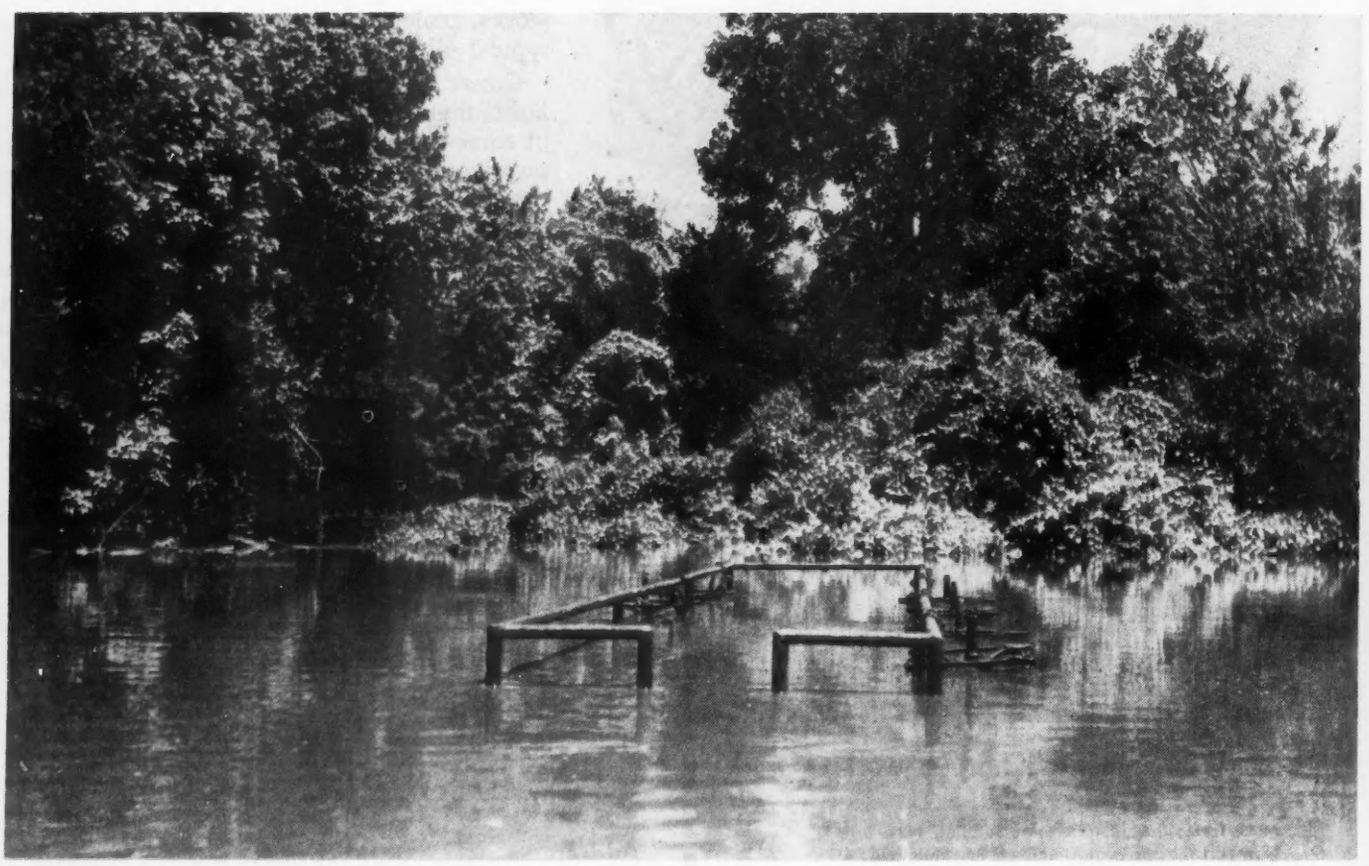
To prevent similar delays in scraper runs in the future, it was decided to build an elevated scraper trap at the control gate platform so that scrapers could be removed from the line during high water.

To do this, 20-foot sections of ten-inch line pipe were hot bent with sand into 90-degree sweep turns on a radius of 12½ feet. Receiving chambers 36 inches long and 12 inches in diameter were welded on the ends of the elevating tubes. When these assemblies were welded into the lines, the receiving chambers extended through the floor of the control gate platform, 15 feet above the ground.

The receiving chambers, which will accommodate any standard scraper, were fitted with 12-inch flanges, four-inch cleanout lines controlled by four-inch plug valves, and ¾-inch drains.

In operation, scrapers are forced smoothly and quickly into the receiving chambers by opening the four-inch cleanout valves. There is no perceptible surge or jar. Then approximately three gallons of oil are drawn off through the ¾-inch drains so the scrapers can be taken out of the line without spilling any oil. A revolving "gibbet" and light hoist built into the platform framework facilitate removal of the receiving chamber flanges.

The same gibbet and hoist are used in pulling out the scrapers and lowering them to the ground. Scrapers are relatively easy to remove from the new trap



Reason for elevating the scraper trap is graphically shown here. Photo was made at the site of the trap during the July, 1947, flood which broke a 103-year high water record. Water was more than 15 feet deep at this point when photo was made.

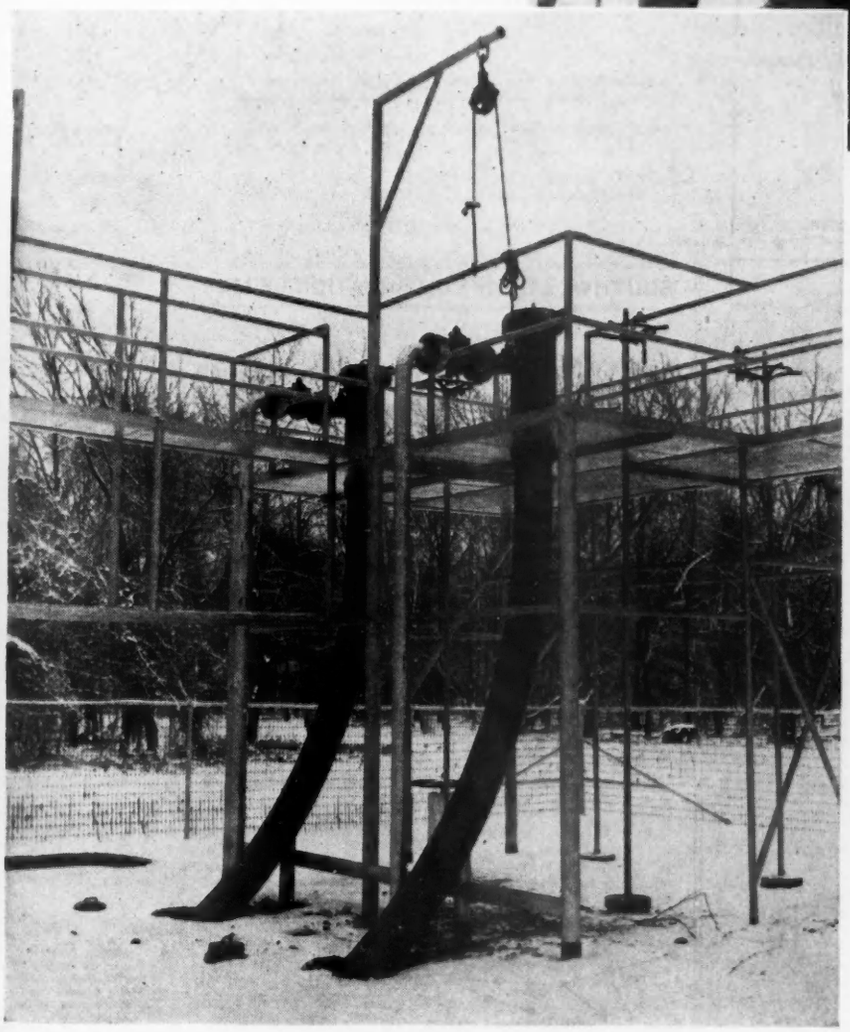
By M. P. CONNOLLY,
Foreman, Ajax Pipe Line Corporation

since they lie free in the oversized receiving chambers.

Finally, the drained oil is poured back into the chamber and the flange is closed. The entire operation, for both lines, can be completed in approximately 20 minutes, and with no loss of pumping time.

Ajax employes responsible for the design and construction of the new scraper trap include members of the construction and maintenance gang and D. H. Hunter, chief deliveryman at Wood River Terminal. The construction and maintenance gang is composed of M. P. Connolly, foreman; T. A. Poynor, pusher; J. L. McCorkle, welder; C. H. Brunson, truck driver; W. S. Litty, welder's helper; and J. W. Merritt, gang man.

Utilityman Roy W. Siddens (left) and Chief Deliveryman D. H. Hunter, Ajax Pipe Line Corporation, removing scraper from new elevated scraper trap on the west bank of the Mississippi River, near St. Louis. Receiving chamber of trap is made of larger pipe than the line, facilitating removal of the scraper.



Located on the west bank of the Mississippi River about 20 miles north of St. Louis, these elevated scraper traps were designed and built by Ajax Pipe Line Corporation to permit scrapers to be run through the Ajax crude oil lines even during major floods.

Pipe Lines of the U. S.

Sinclair Refining Company

Pipe Line Department

51st of a Series

PIPE LINE *Construction*

APPRECIABLE progress was noted in the past month on longer lines already under construction, and preparations for construction of important additions to the U. S.'s products carriers are being made.

The Sinclair Refining Company announced the start of construction of a 387-mile 25,000-barrel per day line from its East Chicago refinery to Carrollton, Missouri, where it will connect with the line now being built from Houston northward. Sinclair is reconditioning pipe from its parallel crude system for use in the new line. Its completion is expected late in summer. Sinclair will then have a line from its Houston refinery to Chicago on the Great Lakes and will serve densely populated Mid-West industrial areas. Sinclair recently put into operation a products line connecting East Chicago refinery with the Marcus Hook, Pa., refinery, and also an extension northward to Toledo and Detroit and southward to Columbus.

Socony-Vacuum awarded contract for its product line in Maine to Associated Contractors & Engineers. Work is to get under way in June.

The products system of The Texas Pipe Line Company and Magnolia Pipe Line Company, originating at Beaumont and extending to the Dallas-Fort Worth area via Hearne, with a lateral from Hearne to Austin and San Marcos, is nearing completion.

Stanolind Pipe Line Company announced plans to construct in July 310 miles of loops on its Casper, Wyo., to Freeman, Mo., crude line, one of its projects postponed from 1947 because of pipe shortage.

The Texas Pipe Line Company has also gotten under way with its crude line to Port Arthur and Port Neches refineries. The new line will pick up crude at the East Houston station 87 miles away and will deliver 120,000 barrels daily.

Rocky Mountain Pipe Line Company's crude outlet from Denver, Colo., to Wyoming is well under way and is scheduled to be completed on July 1.

Pipe Line Construction Activity

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Diam.)	Daily Capacity (Bbls. Cu. Ft.)	REMARKS
CRUDE OIL LINES					
Buckeye Pipe Line Co.	Cygnet to Cleveland, Ohio	110	12	.....	Sheehan Pipe Line Construction Co., Tulsa, starting construction June 1. Scheduled completion July 20.
Continental Pipe Line Co.	From point 3 miles east of Wichita Falls refinery to Ringgold-Joy junction, Clay County, North Texas	16	6	6,000	C. L. Rogers Construction Co., Wichita Falls, Texas, completed early May.
Humble Pipe Line Co.	Albany station to Putnam station, Shackelford Co., West Texas	9	6	.....	Bids being taken for construction of 6-inch and dismantling of 2 miles of 4-inch.
Imperial Pipe Line Co.	Nisku terminal to Edmonton refinery, Alberta, Canada	17	8	.....	Construction to start soon. On both lines.
	Gathering and lateral lines, Leduc field, Alberta, Canada	12	.....	.....	
Mid-Continent Pipe Line Co.	Drumright to Yale, Oklahoma	8	4	2,500	Being constructed.
Pan American Pipe Line Co.	Merigale field to Quitman station, Wood Co., East Texas	5	4	.....	Altgelt Construction Co., Corpus Christi, Texas, completed project, included installation of small pump station at Merigale, in early May.
	Gathering system in Merigale-Paul field	4	6		
		4	4		
Phillips Petroleum Co.	Scattered lines near Odessa, Ector Co., West Texas	3 7/10	24	.....	Vaughn and Taylor Construcrion Co., Wichita Falls, Tex., to complete in Mid-June.
		2 7/10	10		
		6 1/2	8		
		3 2/5	6		
		5 7/10	5		
	Old Ocean field to Sweeny plant, Upper Texas Coast	18	8	.....	Completed by Associated Contractors & Engineers, Houston.
		2	6		
	League City area, Upper Texas Coast	13	6	.....	Takeup and reconditioning completed by Latex Construction Co., Houston.
Rocky Mountain Pipe Line Co.	Denver, Colo., to point 25 miles north of Cheyenne, Wyo.	118	10	26,500	Construction under way by Osage Construction Co., Winfield, Kans., on 10-inch, Goldenstern & Stolper, Ponca City, Okla., on 8-inch. One 650-HP station being built. Scheduled completion date July 1.
	Point 19 miles north of Chugwater, Wyo., to point 11 miles south of Chugwater	30	8		
Stanolind Pipe Line Co.	Sholem-Alechem field, Stephens-Carter counties, Okla.	5	6	.....	Completed early May by Vaughn and Taylor Construction Co., Wichita Falls, Texas.
		1	4		
	Lost Cabin station, Fremont Co., to Arminto junction, Natrona Co., Wyo.	22	12	.....	Contract to be awarded. Work, starting June 1, to be completed June 30. Total project will comprise 57 miles of 12-inch looping from Lost Cabin to Casper, and will be contracted when pipe becomes available later in year.
	Loops on Casper, Wyo., to Freeman, Mo., line	255	16	22,000	Construction planned for July. Contracts for 4 spreads to be let soon. Project includes rehabilitation of 4 abandoned pump stations.
		25	12		
		30	10		
The Texas Pipe Line Co.	East Houston station to Port Arthur and Port Neches refineries, Upper Texas Coast	87	20	120,000	Latex Construction Co., Houston, started work early May
The Texas Pipe Line Co. (Basin Pipe Line System)	Pump station at Midland, West Texas	.....	.....	.....	Contract for station construction awarded to Brown Lane Co., Amarillo, Texas.
The Toronto Pipe Line Co.	Tri Cities field, Henderson Co., East Texas	5	2	2,000	Contract to be let. Construction will include 1 station and loading rack; will start late May, complete Mid-June.
PRODUCTS LINES					
Sinclair Refining Co.	Carrollton, Mo., to Griffith, E. Chicago, Ill.	376	8	23,500	Project includes 4—800-HP stations. Will use reconditioned pipe from Sinclair's parallel crude line. Reconditioning under way by company crews, O. C. Whitaker Co., and Morrison Construction Co., Odessa, Texas.

Pipe Line Construction Activity—Continued

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Diam.)	Daily Capacity (Bbls. Cu. Ft.)	REMARKS
Sinclair Refining Co. (Con'd)	Wild Horse junction to Sand Springs, Tulsa, Okla	19	4	6,000	To be completed, June 1; includes 1—200-HP station.
	Cobb station to Coffeyville refinery, Kans.	16	8	19,000	To be completed, June 1.
	Sinclair, Wyo., to Kansas City, Mo.	700	8	.....	Planned.
	Marcus Hook to Philadelphia, Pa.	26	8	.....	Planned.
	Panova station, Okla., to Redel station, Kans.	290	8	.....	Reconditioning of crude line for products use completed in May by Pacific Pipe Line & Engineers, Los Angeles.
	Redel station to Wood River, Ill.	270	8	.....	Reconditioning of crude line for products use under way by company crews, O. C. Whitaker Co., Ft. Worth, and Morrison Bros., Construction Co., Odessa.
	Redel station and Kansas City, Mo.	20	6	.....	Reconditioning of crude line for products use completed by Morrison Bros. late May.
Socony-Vacuum Oil Co.	South Portland to Bangor, Maine	127	6	11,500	Contract awarded to Associated Contractors & Engineers, Houston.
The Texas Pipe Line Co.	Hearne to Austin, South Texas	79	8	.....	Completed by Latex Construction Co. Work started late April on 28-mile 6-inch line from Austin to San Marcos. Both lines part of Beaumont-Hearne-Dallas system being constructed.
NATURAL GAS LINES					
Chicago District Pipe Line Co.	From vicinity of Joliet to southern limits of Chicago, Ill.	41	24	.....	Application for looping of Calumet line before FPC. Peoples Natural Gas Co. would loop 7-mile section of Calumet line from Chicago city limits to their Calumet gas plant.
Cities Service Gas Co.	Ulysses, Grant Co., to Hutchinson, Kans.	183	26	90 mln.	Contract awarded to Ray L. Smith & Son, El Dorado, Kans.
	Ottawa, to Galvin junction, near Olathe, Kans., to point across Missouri border	48 2	26 24		Midwestern Constructors has work under way.
Home Gas Co.	Horseheads to Dundee, N. Y.	25 10	10 12, 6, 4	.....	Contract to be awarded includes 1—1400-HP station. Work to start August.
	Hancock to Cochecton, N. Y.	26	12	.....	Contract to be awarded. Work to start July, complete September.
Hope Natural Gas Co.	Lockney, W. Va., to point 13 miles to north	13	.....	100 mln.	Construction under way by Pipe Line Construction Co., Comp Hill, Pa.
Independent Natural Gas Co.	Alvin area, Upper Texas Coast	5	6	.....	Contract awarded to Associated Contractors & Engineers, Houston.
Kansas-Nebraska Natural Gas Co.	Elm Creek, Neb., north	35	.....	18 mln.	FPC approved application, including looping of Scott City-Cambridge and Scott City-Holdrege lines, and continuation of present Otis-Stockton line as far as Phillipsburg. One compressor station, 1600-HP, to be built.
McCarthy Oil & Gas Corp.	Jackson Pasture to Winnie plant to Orange, Upper Texas Coast	9 19	20 16	.....	Two spreads completed by Anderson Brothers Corp., Houston.
Northern Natural Gas Co.	Gathering system, Hugoton field, near Sublette and Satana, Kansas	14 12½ 19	20 16 8⅝	.....	Contract to be let, including 17 miles of 8⅝-inch line for takeup and reconditioning. 2-inch and 8-inch to start June 1; 16-inch to start in September.
	Loop from Clifton station, Kans.	11	24	.....	Loop on third line starting July 1, by C. S. Foreman Co., Kansas City, Mo.
Southern California Gas Co. and Southern Counties Gas Co.	Point ½ mile east of Rivera to 30-inch line near Pasadena, California	12	30	.....	Application to FPC.
Southern California Gas Co.	From 30-inch line near Desert Center to Imperial Valley	72	4-16	.....	Application filed with FPC.
Southern Natural Gas Co.	Looping near Pickins, Miss.	40	24	.....	Sheehan Pipe Line Construction Co., Tulsa, to start construction in July.
	Loops near Birmingham, Ala.	35	24	.....	H. C. Price Co., Bartlesville, Okla., to start work in June.
	Looping from Leeds, Ala., to Carrollton, Ga.	61	24	.....	Latex Construction Co., Houston, to start work July 1.
Stanolind Oil & Gas Co.	Wink, West Texas	35	.....	.....	Gathering and redistribution system completed late May by McVean & Roberts, Odessa, Texas.
Tennessee Gas Transmission	Point north of Batesville to point northeast of Webb, Miss.	45	26	.....	H. C. Price Co., Bartlesville, Okla., starting loop June 15.
	Loops along main line	992	26	340 mln.	Amended application filed with FPC.
	From northeast Kentucky through Ohio and Pennsylvania to Buffalo, N. Y.	395	26		
	Point on main line in Columbiana Co., Ohio to point in Allegheny Co., Pa.	44	16		
	Lateral gathering lines	30	16		
	Carthage field, East Texas to Natchitoches, La.	73	20	.....	Completed by Latex Construction Co., Houston, in May.
Texas Eastern Transmission Co.	Skippack to Broadaxe, Montgomery Co., to point near Cheltenham, Pa.	20½ 6	12 8	.....	Midwestern Constructors, Tulsa, started construction May.
	Conshohocen, Pa. to point near Chester	1	6		
The Texas Production Co.	Lake Salvador and Delta Farm fields to LaFitte plant, La.	17	8	.....	Completed in May by Associated Contractors & Engineers, Houston.
Texoma Natural Gas Co.	Near Kingsmill, Texas Panhandle	2	4 & 6	.....	Vaughan and Taylor, Wichita Falls, Texas, also taking up 7 miles 24-inch, 2 miles 10-inch, ⅛ mile of 8-inch, 2¾ miles of 6-inch, 1 mile of 4-inch.
United Gas Pipe Line Co.	Dallas junction to 16-inch line serving Dallas Power & Light Co., plant, Dallas Co., North Texas	1⅞	12	.....	Completed by O. C. Whitaker Co., Fort Worth, in May.
	Loop from Latex—Ft. Worth line to Texas Electric Service Co. at Handley, Tarrant Co., North Texas	4½	12	.....	Completed by O. C. Whitaker Co. in May.
	Near Van Zandt and Kaufman county boundaries, west of Willis Point, due west	16	18	.....	O. C. Whitaker to construct during summer. Loops Latex-Ft. Worth main line.
	North of Hawkins, Wood Co., to Mineola, East Texas, station	2⅜10 15½	14 16	.....	O. C. Whitaker Co. to construct during summer. Loops Mineola station 18-inch suction line.
	Mineola station, to point west, in East Texas	13	18	.....	O. C. Whitaker will construct in summer. Loop on Mineola 14-inch discharge line.
United Natural Gas Co.	Replacement of 12-inch line, Elk Co., Pa.	20½	22	.....	Application filed with FPC. Also included are short connecting lines in Jefferson and Clarion counties, Pa., and additional compressor units.
	From storage field to compressor station, Elk Co.	29	12		
	From storage field to station, Jefferson Co., Pa.	4½	10 or 12		
Warren Petroleum Corp.	Gathering system at Mayesville, Okla.	200	.....	100 mln	Scheduled completion date January 1, 1949.

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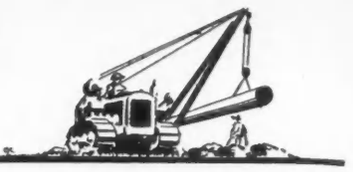
How to do it! PIPE LINE HINTS



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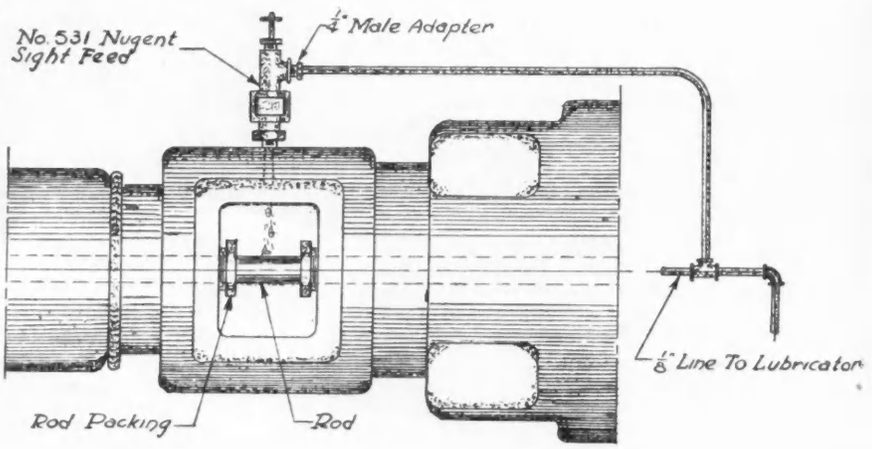
HOW TO—Automatically Lubricate Compressor Rods

An important phase in the maintenance of pipe line compressors is constant lubrication of the rods connecting the compressor piston with the power end of the unit. Certain types of compressors are equipped with the regulated-type sight feed lubricators which are subject to running out of oil, and which continue to drip oil on the rods even after the compressor is shut down.

Both conditions have been eliminated at one compressor station by an ingenious device rigged by the station engineer. The lubricating system which furnishes lubrication to the rods and rod packing glands was connected into the compressor force-feed lubrication system. The regulated sight feed lubricator was replaced with a No. 531 Nugent sight feed lubricator which contains a means for adjusting the flow of oil through it. A male adapter screwed into the regulator accepted the ⅛-inch line which was tied into the lubrication system through a Tee, as illustrated.

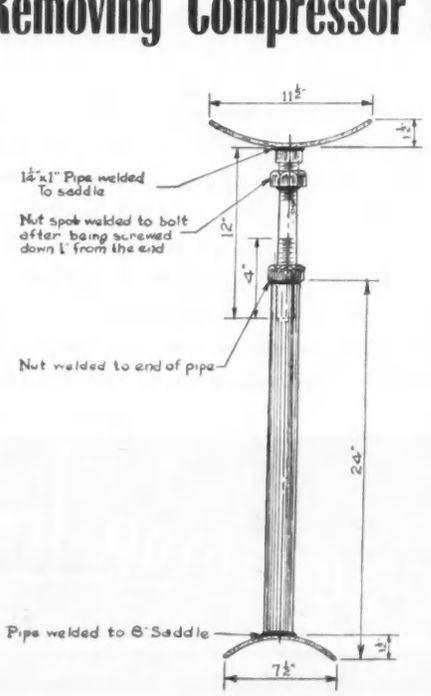


When the compressor is in full operation, the lubricator is adjusted so that about three drops of oil are delivered to the rods per minute. The oiler can forget about this phase of compressor maintenance, since the rods will be supplied oil from the force feed lubrication system, and will only receive oil as long as the compressor is operating. When the engine is shut down, the oil automatically stops flowing. It is estimated that this device has saved approximately 50 percent of the lubricating oil normally used for this purpose.

HOW TO—Ease Job of Removing Compressor Head

On certain types of compressors it is necessary to remove the compressor head when making repairs such as replacing piston rings, etc. Because of the weight of the horizontal head, it must have some support during this job. This operation has been simplified considerably by the use of a shop-made screw jack that remains in position during the job. The jack contains a saddle at both ends to fit the curvature of the gas intake and compressor head.

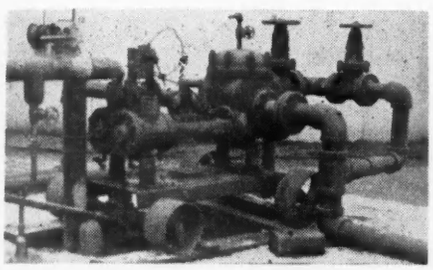
The unit consists of a 24-inch section of 1¼-inch pipe, to the bottom of which was welded a 2½ x ¼ x 8-inch strap iron curved to fit the suction or discharge line of the compressor. A standard 1¼-inch nut was welded to the opposite end of the pipe. A 12-inch standard 1¼-inch bolt with four inches of threads on one end and about two inches on the other end. A nut is screwed down on the bolt on the short threaded end and that end of the bolt welded to a 2½ x ¼ x 12-inch saddle curved to fit the side of the cylinder. The nut is spot welded to the bolt and provides a means of screwing the bolt in and out of the section of pipe.



In use, the jack is placed so the bottom saddle fits on the discharge and the top saddle fits around the compressor cylinder. The flange bolts on the cylinder are loosened, and the jack is raised slightly to break the seal, thus greatly facilitating the removal of the head. After the seal is once broken, the head can be worked off the piston. The device has been used successfully and saves approximately 30 minutes on each compressor head removed.

HOW TO—Add Portability to Pipe Line Emergency Pump

When one of the pumps at a tank farm suddenly develops mechanical trouble, or a clean-out pump is required to handle oil, water, tank bottoms, or wash solution, a duplex steam unit mounted



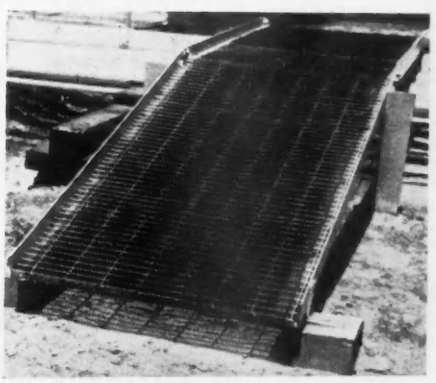
directly upon wide iron wheeled trucks has been found to be of valuable assistance to the operators. At the time this unit was assembled, truck wheels with tires wide enough to support the pump on soggy ground were not available. Therefore, wheels were made to order in the company shops. These wheels are made by cutting a section from 8- and 10-inch pipe so that these nipples are approximately 6 inches long, thereby forming tires having a width of six inches. Spokes, made of heavy flat steel are welded inside the tires, staggered to obtain the necessary bracing, after which the hub, or spindle sleeve is inserted.

The bed for the pump is a length of wide flange channel iron set solidly on the rear axle, and mounted at the front with a "fifth" wheel over the front axle for towing control. The assembly can easily be moved around the tank farm by attaching the tow-bar to the trailer hitch of a pickup and placing it on a temporary foundation for emergency operation.

HOW TO—Make Pipe Line Overpass

Where a compressor station is built with all lines laid above the ground to preserve the metal and prevent soil corrosion, men obviously must pass frequently from one station to another in the plant. To prevent accidents caused by tripping over the pipes, a steel grated walk is built having long approaches so men can readily walk when carrying boxes of tools or fittings to be used in maintenance of the lines and the plant.

Concrete piers in the form of square upright posts are placed in pairs on either side of the group of pipe lines a sufficient height above the piping so that the flat portion of the walk can be laid level and horizontal. Low piers are



placed at the end of each ramp to which side members supporting the walk are securely bolted.

HOW TO—

Make a Piston Wrench

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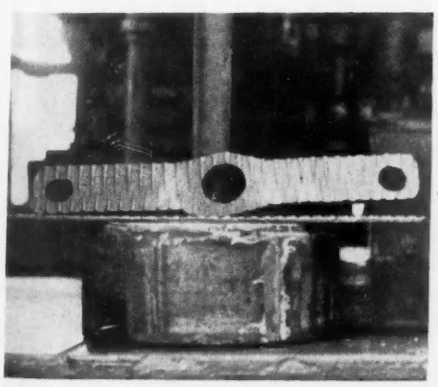

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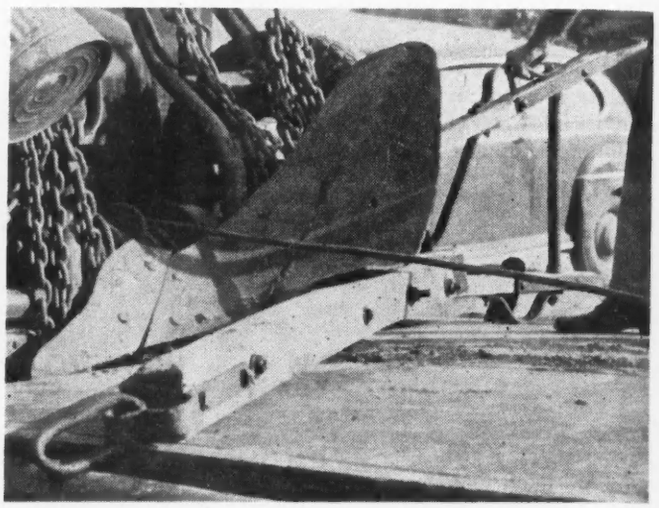
Be Sure to Check
The Trading Post
Page 306

HOW TO—Make Plow for Tearing Up Soft Soil



One pipe line contractor found that the plows fabricated for tearing up soil in front of the ditchers did not give best results in loose soil. Therefore, after obtaining the largest conventional plow possible, he added 12 inches to the sweep by welding on a section of quarter-inch plate steel. This allows the plow to be thrust farther into the ground, yet making a clean ditch which requires little "crumbing" on the part of ditching gang.

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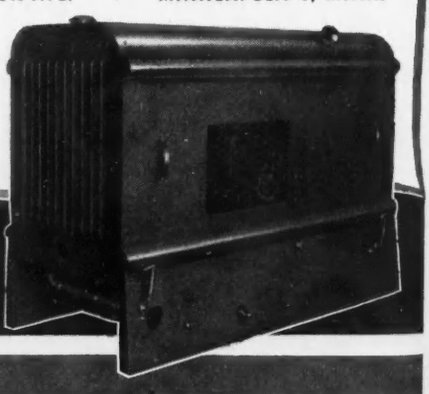

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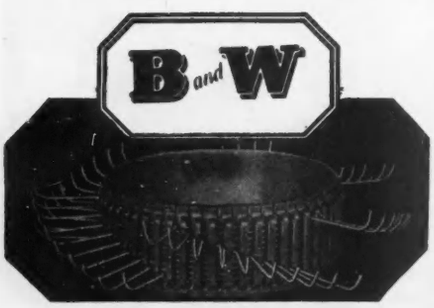

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PIPE LINE HINTS

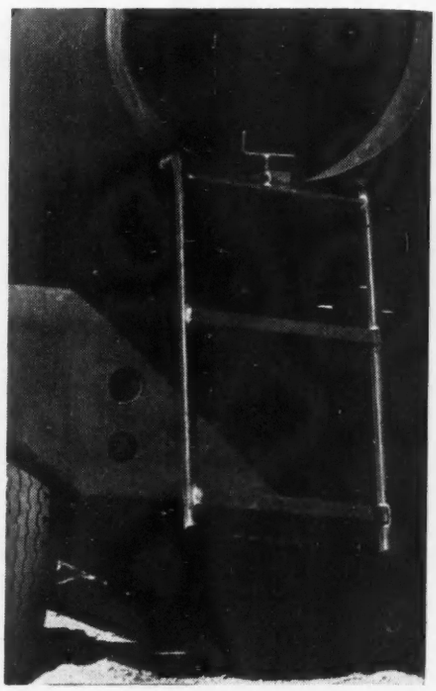
HOW TO—Construct Detachable Step Ladder

In loading and unloading large diameter pipe, it is a struggle to get atop the load to position the boom hooks, etc. One trucking company fabricated a handy two-rung step latter that could be used on various sizes of relatively large diameter pipe for the purpose of aiding the loading crews in getting on and off the load of pipe.

The ladder is simple to build and requires little material. Two 1½-inch pipe runners, about four feet long, are bent at the end as shown to form an angle of about 115 degrees. These are joined at the opposite end by a cross piece of strap steel about 24 inches long. A second rung of the same material is welded at the mid-point of the pipe runners. Footing surfaces are added so that when the ladder is placed on the pipe as illustrated, the footing surfaces are horizontal.

The runners are joined at the top with a third cross piece to the center of which is welded a flat "C" clamp. The clamp is simply a piece of flat metal that has been folded back on itself and drilled and threaded through one side. A threaded bolt with a cross handle completes the unit.

The ladder is fastened to the large pipe by placing the lip of the pipe in the "C" clamp and tightening the bolt.



The ladder is further supported by the bent sections of the pipe runners that bear against the pipe. The ladder is quite useful and easy to use. Where many loads of large diameter pipe must be made, such a device will save time and reduce possibility of an accident in climbing on top of the pipe.

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Wild Well

Is Major Setback for Leduc Field

—Acme Photo

Seething, bubbling lake of oil covers area around Atlantic 3, Leduc field.

A SINGLE WELL flowing out of control in the center of the Leduc field has caused a major setback in the operation and development of what would have become Canada's largest single source of crude petroleum within a few months.

On May 12 orders were issued by the Alberta government agency in charge of petroleum affairs to close in all of the 60 wells in the field, and it was unlikely that any of them would be allowed to produce before early June. The unusual nature of the wild well, and the complexity of the problems of bringing it under control are likely to require a minimum of three weeks before the flow is halted.

Atlantic Oil Company, an independent producing firm of Calgary, owns a lease on 160 acres in the center of the field. Two successful producers had been drilled before starting No. 3, and operations had proceeded normally on the third well until drill stem became stuck during a blowout at the gas-oil contact after reaching the producing formation. While making efforts to free the drill stem, it was pulled apart 800 feet below the surface. The blowout subsided within a short time, and it seemed a routine job to clear the hole.

Oil started slowly rising in the hole and reached the surface on March 14. Even then it was not flowing a great deal of oil through the well bore, but later it was noticed that oil started seeping through fissures in the earth at some distance from the well, slowly at first and then more rapidly until it was making an estimated 3000 barrels daily over an area of 25 or 30 acres around the well. When the Conservation Board took over the well to make efforts to kill it, the flow of oil was estimated at 10,000 barrels a day along with an estimated 75 million cubic feet of gas.

A peculiarity of the situation is that there is no great flow from the well bore itself and there is no evidence of cratering in the vicinity of the well. Theories have been advanced that the oil is probably coming almost to the surface in the well bore itself and then perhaps spreading through a porous formation near the surface. Apparently there are such formations which are not isolated by the surface casing normally set in Leduc drilling wells.

A 20-foot dyke had been thrown up to enclose 30 to 40 acres around the well and collect the oil which is picked up by pumps as rapidly as possible for movement through the field's gathering system to the eight-mile pipe line to the loading rack at Nisku. The primary reason for shutting in the field, regardless of the safety considerations, is the fact that the system, plus the number of railroad tank cars available, cannot handle more than 9000 barrels daily and every effort is now being made to secure more cars to meet the emergency. The entire field, at the time the Atlantic well started running out of control, was making only about 8000 barrels a day. In the middle of May an estimated 60,000 barrels of oil were collected inside the retaining walls around the well with little chance of making much headway against the flow.

Board Takes Over

Imperial Oil Company, Ltd., principal operator in the Leduc field, at the request of the Conservation Board and with the consent of Atlantic Oil Company, prepared to take over the attempted control of the well but it was found that legally it could not do so, so the operations were officially taken over by the Board, and Imperial Engineer V. J. Maroney has been loaned to the board in an advisory capacity and to direct actual work. Experts were also loaned by Humble Oil & Refining Company for consultation. Previously, about 10,000 sacks of cement had been pumped into the well without any effect.

Also on the job, arriving May 14, are the M. M. Kinley fire-fighters and experts on controlling wild wells.

The process planned for bringing the well under control is drilling of perhaps two directional wells, started at distances of more than 600 feet from the well-head, one of which is to be deviated so as to strike the producing formation in the vicinity of the well bore, and the other perhaps somewhat higher. It is thought that drilling these may take as much as 60 days, and if so the total cost of the project, plus lost production for the remainder of the field, will run into several hundred thousands of dollars. Meanwhile, an attempt was being made to remove the drill pipe and perhaps localize the flow somewhat.

Operations will be considerably hampered until the surface oil can be cleared away and facilities arranged so that it can be picked up as fast as it accumulates. An attempt also will be made to pump part of the oil back to the formation through another well. By that time it is hoped that transportation facilities will allow partial operation of the field.

Under present conditions the area constitutes a grave fire hazard and every possible security measure has been installed. Aircraft are forbidden to fly over the area, sightseers are banned, and workers are not allowed to carry any kind of smoking equipment.

This is the first major mishap in the field, which was opened by Imperial in February, 1947. Its 60 producing wells were making 100 to 150 barrels each under conservation restrictions, and local oil men estimated that by the end of 1948 the field would be producing 25,000 barrels daily. Byproducts of the discovery have been the exploration campaigns launched by many operators in the Alberta Basin with discovery of several new producing areas and expansion of existing fields. Leduc has also been responsible for starting of Canada's largest pipe line project, a 500-mile system to link Leduc and other fields in Alberta with refining centers in Saskatchewan.

Germany attacks OIL PROBLEMS

by

A. H. STAHMER

Marne-Meldorf 13, Heide field extension well, rigging up.

THREE years after the cessation of war operations the German oil industry is still in a transitory phase. As are most facets of German economic life, its most important functions are still subject to a centrally directed system of economic control. There seem no prospects of the industry regaining full freedom of action within any measurable period of time. The entire economic recovery of the country, which is the stated primary aim of the occupying powers, is dependent to a large extent on the condition of the oil industry. Gasoline, fuels, and other mineral oil products play an important part in the economic life of any modern nation. The extreme shortage of these products in Germany is a factor retarding general economic recovery, yet at the same time it is thought that continuance of centralized control for an indefinite period, with consequent restriction of free and full development of the industry is inadvisable and undesirable. The present system of "trading from one pot" with frozen prices and market shares is by no means an ideal structure.

Since 1939, conditions in the international oil markets have changed considerably. At the same time domestic factors of the oil industry in Germany have changed; factors such as the extent and location of production sources, the capacity of refineries, facilities for transportation and distribution and many others. A new situation will arise from the fact that Germany, with the help of the Marshall Plan and the foreign exchange paid for her exports, again will be able to import a substantial portion of her essential oil needs from abroad. Considerable imports will be needed, if only because of the fact that the domestic production of gasoline from coal is no longer available. The Oil Plan, product of cooperation between British and German authorities, will take these circumstances into consideration.

Imports Problem

When the first draft of the plan was published in September, 1947, the commercial and industrial circles involved were faced by the question of deciding what principles should govern the handling and distribution of the imports. The idea of using the structure of the prewar import trade as guidance was eliminated from the beginning. The Roumanian and Russian connections of that

Portable telescope mast for hole cleaning at Meldorf 68 in the Heide field.

period have been cut off, and before the war there existed no closer connections with the Middle East, now regarded as the export center of the future

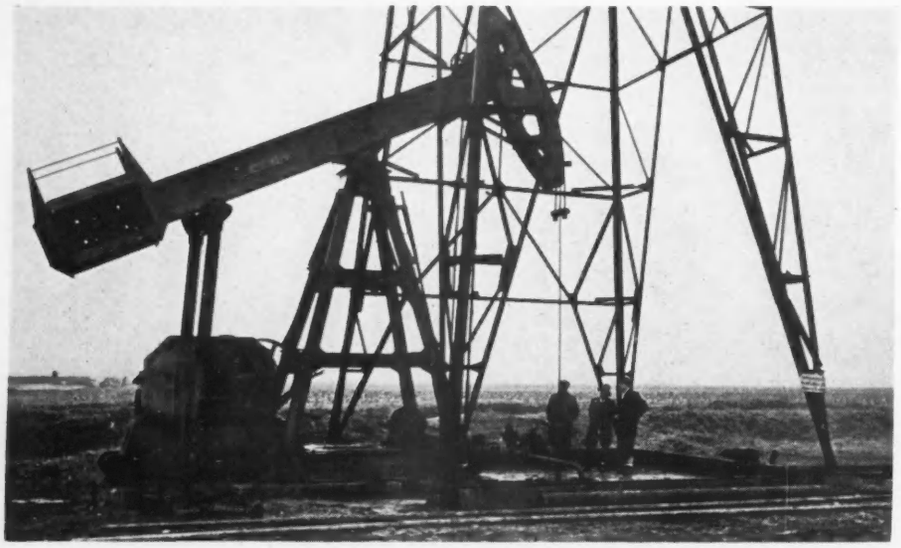
In November, 1947, the suggestion was made that the local importers organization ask the Allied authorities to use the actual market shares of the companies as a basis for granting import licenses. Under this arrangement it would primarily be the task of the large distributing companies such as those owned by the Shell group, Standard Oil Company (N. J.), Socony-Vacuum Oil Company, and Anglo-Iranian Oil Company to arrange the imports by making use of their close foreign relations . . . still no easy task in view of the general oil and transportation shortage throughout the world. Protest against such an arrangement was registered by a group of firms possessing large refining capacities with relatively small and ineffective marketing organizations. These companies thought that refining capacity should be used as the distribution index rather than the value of market shares. The majority of the companies, however, thought that these individual operators, especially those whose plants suffered little or no damage during the war, would be unduly priviliged by such a procedure. Some firms with relatively small market share quotas raised the objection that the time had arrived to lend a free hand to the initiative of importers so that a better chance would be offered to get the needed products on lower bids and perhaps save on short foreign exchange. The other companies held that long-term, large-scale import agreements such as are now demanded by the major suppliers could not be concluded if suppliers were placed in a position where they might, by accepting chance offers, obtain slightly better advantages.

It is apparent from conferences of the association of the oil industry in Germany, that most importers would like the oil imports to fall under the provisions of the Joint Export Import Agency (JEIA) Directive No. 10, which leaves a certain amount of flexibility allowing more freedom of action to the individual firms. However, the Oil Branch Fuel and Power Division has announced that this would not be the case, that the decision on imports would be placed in their own hands, to be directed jointly by the Oil Branch and by JEIA. It is possible that there may be some relaxation of this measure, particularly since some of the former outside relations have been resumed between the German as well as the foreign-owned companies with outside suppliers. It is also presumed that it will be found that companies operating within the country will be the best judges of import requirements. A slackening of this decision seems to be indicated by a contract recently concluded with the U. S. for about 100 tons of paraffin, which takes the JEIA Directive 10 as its basis.

Marshall Plan Awaited

The situation is still fluid, and it is to be supposed that the matter of oil imports as well as the total export trade will take final form only after the full program of the Marshall Plan gets under way. German operators hope that, acting under the provisions of the new conditions, they will then have an opportunity to show that the domestic industry is responsible and may be expected to promote the recovery of German oil economy.

During the first quarter of 1948 only about 110,000 barrels of crude were imported into Germany, that being the last delivery of Venezuelan crude under a Standard of New Jersey contract. In order to satisfy a portion of the urgent demands in the British and American zones of occupation, the Allied forces have diverted substantial amounts of army reserve finished products, mostly gasoline and diesel oil, to the use of German industry. This was required by reason of the low level of imports during the last



Pumping unit at Meldorf 42.

quarter of 1947 and the first quarter of 1948. During the first quarter of this year only 1,648,000 barrels of gasoline and diesel oil have been brought into the country, an average of slightly more than 18,000 barrels a day of both these essential products. Imports were almost equally divided between the British and American zones, including their respective portions of Berlin, with slightly more than half going into the British zone. Since then two tankers with about 210,000 barrels of crude have arrived from the Caribbean area, and another was scheduled for arrival in May, so that the total for the second quarter should show a substantial increase in accordance with the oil plan.

Refining Activity

Refining activity during the first quarter of 1948 finds the industry turning out 1,228,000 barrels of finished products, comparing very closely with the level of operations during the last quarter of 1947. The supply of crude to be supplied from outside the country under the Oil Plan is not yet fully under way; consequently, with the relatively small supplies of indigenous crude available, the German refineries are still operating far short of capacity. The products manufactured during the first quarter of this year showed a substantial increase in the amount of lubricating oil of various grades as compared with gasoline and other fuels, while the refineries' own consumption of distillation residues and fuel oil amounted to about 150,000 barrels, or about 15,000 barrels more than was used for the same purposes during the last quarter of 1947.

According to a recent agreement the big German Wesseling hydrogenation plant near Cologne is to be used for the purpose of treating imported crude. At present the plant is only utilizing a small part of its potentialities by producing methanol and ammonia. The owners of the plant, Shell group and a German concern, have agreed that the unit is to be placed at the disposal of Shell for the purpose of treating crude to be imported under the Oil Plan. The arrangement will only affect the distillation capacity of the plant, but will make possible the use of capacity which is now idle. The schedule calls for commencement of operations by the first of July with a daily throughput of 7000 barrels of crude. It is anticipated that this will be increased to double that amount by the end of the year, which would be the greatest of any of the German refineries.

Exploration Active

In attempts to maintain, and perhaps increase, present production of crude from German fields, the industry is maintaining a high percentage of exploratory drilling. During March, more than one-third of the total footage drilled was in exploratory wells, the remainder being development wells and extensions to producing areas.

During March the fields of Germany produced a total of 358,613 barrels of crude, a very welcome increase following a slump during January and February, and representing a gain of nearly 32,000 barrels over the preceding month. This brings total output for the first three months of 1948 to 1,018,380 barrels. Since the normal production trends in Germany find production at a peak during the summer months, it is hoped that 1948 will see a slight increase over last year, when the production had dropped to a low of 4,029,308 barrels. During 1947 it is felt that the full productive ability of the fields was not reached due to the abnormal cold weather of the early part of the year. The greater part of the March increase was contributed by the Neinhagen, Wesendorf, Heide and Reitbrook fields. Emlichheim, looked toward as an important future source of production with further development, also showed an increase, and it is hoped that development will be stimulated by the recent agreement with the Dutch authorities which will make it possible to proceed with orderly development of the field without the restrictions which ordinarily would be imposed on an area that lies athwart an international boundary. Further encouragement for increased output of the country was given by the preparations for the beginning of commercial production from the Adorf field, a producing area discovered during 1946 in the Emsland region, which has never been on production. In the Georgesdorf area, also in the Emsland, a new feeder line has been laid by the Preussag company so that five additional wells will be able to go on production. The Adorf field will give the Emsland its fourth oil producing area and increase its participation in the total output. Currently, three-fifths of production comes from the Hanover fields, which produced 218,835 barrels of oil in March.

The fourth wildcat drilled by Gewerkschaft Elwerath on the Stemmer Mountain prospect about six miles west of Hanover recently found oil showings in the Cornbrash sandstone of the Middle Jurassic. Production tests indicate it will not, in all probability, be of major importance. Thus far it has tested six to seven barrels of heavy oil daily. Of particular interest is the fact that the geologic structure of the Stemmer Mountain prospect differs materially from the usual type of structure from which most of the Hanoverian fields produce. It appears to be a mountain saddle of complicated structure thrust over its northern foreland. All of the fields in the surrounding districts of Celle and Brunswick produce from salt dome structures.

The Oil Branch, Fuel and Power Commission is taking an active interest in the establishment of petroleum reserves in Germany and is supporting the search in a number of ways. Two complete seismic exploration outfits had been ordered from the U. S. through the Oil Branch, and were scheduled for delivery in Germany in June. They are to be placed in commission immediately upon receipt for work in the northwestern part of the country.

Exploration is under way in the Meldorf area, a part of the Heide group of fields northwest of Hamburg. Most of the work is in the nature of shallow-well structure drilling checked by deeper outpost wells, two of which are now being drilled on the south side of the field, and structure drilling continues in the tideland area between Meldorf and Dieksand.

Seismograph Surveying In Central Alberta

Surveying in "muskeg" area can be done more effectively in winter than in summer, when area is too boggy.

By E. J. HANDLEY
Vice President
Century Geophysical Company

DISCOVERY of Leduc and other new areas in Western Canada has attracted the attention of many new operators, many of whom had overlooked the potentialities of the region as a major oil territory. The accompanying article discusses some of the problems of year-'round geophysical operation in the Alberta Plains and Foothills, and the development of new techniques and equipment to facilitate winter operations. Attention is also called to the cooperation of Canadian officials, who welcome operators from outside the country.

WESTERN Canada today presents tremendous possibilities to the American oil operator. Perhaps the biggest boom in the oil industry at the present time is centered in Central Alberta; at least the activity there is increasing at a greater rate than elsewhere. Strangely, comparatively few oil men in the U. S. are cognizant of the favorable conditions which prevail in that new region, both from operational and economic standpoints. Canada is doing everything possible to attract, rather than repel, the American investor.

Reasons for Boom

There are many reasons for the Canadian boom. The price of oil created by the demand is fundamentally responsible. The tremendous potentialities of Western Canada became apparent to the industry as a whole by the discovery of the great Leduc field by Imperial Oil Ltd., on February 13, 1947. Estimates for the ultimate recovery from this field have run as high as 250 million barrels.

The Leduc discovery made the entire Plains area attractive, although at the present time most of the activity is concentrated in the area between Calgary and Edmonton, which includes the Leduc district. This is partly due to the fact that oil men are somewhat prone to follow along a trend where a discovery has just been made, but also partly due to sound reasoning. Geologists know that reefs are very closely controlled by water temperature and water depths. It is natural that they should consider reservations more or less along the same strike with Leduc as most attractive, as one might expect conditions which existed in Devonian time creating the Leduc reef to be repeated more or less along the strike. The entire Plains area is rapidly being reserved, however, because folding and limestone porosity, like gold, are where you find them.

Just as Leduc gave evidence of the potentialities of the great basin area, the recent Gulf discovery at Pincher Creek has renewed interest in the entire foothills area as the structure is similar in type to Turner Valley and Jumping Pound.

The current oil boom has resulted in a very rapid expansion of seismograph activities in Alberta. Before the war only a handful of seismograph crews operated there and these generally worked only during the summer months. Imperial pioneered the idea of keeping a seismograph crew working all year, and was pleasantly surprised at the results. About 35 seismograph crews are now operating in Alberta, with estimates of 50 to be working by early summer.

Aid from Government

Men naturally fear the unknown, and oil men were no exception in rather pessimistically expecting greater difficulties in beginning seismograph operations in Canada this past winter than were actually encountered. The red tape of getting men, equipment and supplies into the country has been reduced to the minimum by the Canadian government,

Setting up to drill another shot-hole. Note portable steel slush tank used while working snow-covered, frozen terrain.

and these details have been expedited by the Western Canada Petroleum Association. This association, through Ed Kolb, secretary, performs a most excellent service for the members.

When an oil man speaks of having trouble, that is sometimes tantamount to saying he does not have the proper equipment or the necessary personnel to do the job. If the seismic equipment is properly designed and operated by competent personnel, no more trouble is encountered in Canada in winter than in any other area. In fact, it is more efficient to shoot many areas in the winter time than in the summer because much of the area is muskeg or swamp-like in character.

Winterizing Equipment

The equipment must be adapted to the field conditions. In Canada during the winter, cold alone is the biggest problem—and the answer to cold is heat. The equipment can be easily and cheaply winterized. The surveying presents no unusual difficulties other than that a pickup on four-wheel drive or a similar unit should be used as the surveying truck, and it should be properly insulated and heated. Ordinary hot water heaters are entirely satisfactory. All personnel must wear proper clothing and this generally can be found at Army-Navy Stores or through the War Assets Administration outlets.

The drills need merely have a hood built around the mud pump, into which the truck exhaust gases are piped to protect the pump. The secret of successful winter drilling in Canada is simply to have available "hot" water to use to provide drilling mud. The water trucks can be easily and effectively winterized by means of a "weed-burning" flame thrower. These flame throwers burn kerosine and put out a tremendous quantity of heat, which can be piped throughout the water tank in stainless steel pipes.

The recording truck instrument cab must be properly insulated and heated, and a heating box must be built around the chemical pots to keep the photographic chemicals properly warmed. The cab must be kept warm day and night to preclude moisture condensation. If the recording truck can be driven into a storage place at night where electricity is available, a large light bulb burning inside the cab will eliminate moisture condensation in the instruments.

The seismic interpretation problems are no worse than in any other area. The Plains area is largely covered with glacial drift and in many areas a two-layer problem exists and approximate corrections must be made from the first arrival times to allow for the amount of low velocity material not penetrated by the shot hole. Records generally are better in winter than in summer because less ground roll is created by the shot when the muskeg is frozen, if muskeg is present. The foothills region has the usual migration problems peculiar to any steep dip area. Considerable faulting, including overthrusting, is present all along the foothills zone, and velocity gradients should be approximately accounted for.

The oil business, and therefore the seismograph business, is directly controlled by the government, largely through the Department of Lands and Mines, a branch of the Provincial government. This department administers its business as a board of equity and bases its policies, not on statutes created by legislation, but on the decisions made by men who are committed to the political party, and thence to the people. Perhaps the most profound statement concerning government ever made by man was made many centuries ago by the Greek legislator, Solon, when he proclaimed, "A people get as good a government as they deserve." His statement could be paraphrased to read, "A people get as good a government as they demand." The people of Alberta support a liberal and progressive party. This party is not socialistic and is definitely anti-communistic. The Hon. N. E. Tanner, Minister of the Department of Lands and Mines, has expressed in simple terms the objective of his administration as far as the oil business is concerned; namely, to administer the affairs of the oil industry in Alberta in such a manner as to derive the greatest benefits for the people of the Province. They have no intention of killing the goose that laid the golden egg; they are encouraging in every way possible the entrance of American oil companies into Alberta, and it must be assumed that the department's policies in the future will be such as to result in profitable operations for these companies. Furthermore, the department is quite anxious to see American independent oil men come into Alberta and their tax program encourages this.

Tax Inducements

The corporation tax in Canada is 30 percent on net income. There is an additional 5 percent Alberta Province tax on net income, making a total of 35 percent. A Canadian incorporated subsidiary would pay an additional 5 percent on any dividends it might pay to its American parent. There is no capital gains tax in Canada, which should serve as an alluring incentive for American independent producers. Furthermore, the depletion credits as allowed in this country are also granted.

There are other incentives for American capital to enter Canada. The entire Western Canadian basin, including the foothills strip, is a potential oil producing area and lease acquisition costs are negligible. Acreage blocks can be ob-

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tained in reservations up to a maximum of 100,000 acres and two reservations may be held at any one time by a person or company. A reservation is issued for a fee of $250 and a deposit of $2,500 for each 20,000 acres or portion thereof comprising the area applied for. The deposit is returned after a satisfactory survey has been conducted.

Credit Provisions

Credit is allowed on up to 50 percent of the expenditures incurred for application to the rental for one year only of any lease acquired out of the reservation. If the holder of a reservation extends his operations into a second year he must pay 7 cents an acre for each of the first two renewals which are of three months duration and 8 cents an acre for each of the next two renewals which are also of three months duration. If drilling of a well is in progress at the completion of the second year the reservation may be further extended while the drilling progresses for 10 cents an acre for the first three months, 15 cents an acre for the second three months, 20 cents an acre for the third three months and 25 cents an acre for the fourth three months. The cost of extensions for the second year totals 30 cents an acre and the cost of extensions for the third year totals 70 cents an acre. When it is considered that in the U. S. most of the more favorable basins are practically leased solid and that the available acreage is invariably scattered, the advantages in Canadian operations from a land standpoint can be appreciated.

It should not be assumed, however, that exploration costs in Canada are low. A seismograph crew engaged in winter operations will average around $20,000 per month. One contributing factor to the higher operating cost is the necessity for the almost continuous use of one or more bulldozers to make roads for the seismograph trucks. However, production is generally good and the cost per profile can easily be kept below $100. One seismograph crew with which the author is familiar shot 444 quarter-mile spreads, or 220 holes, during January in the Peace River country.

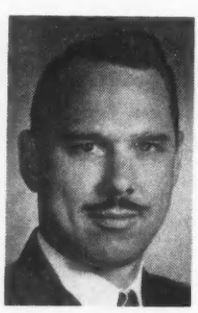
Gravity Meter Work

In addition to the various seismograph activities in Alberta, there is considerable gravity meter work being done, and more undoubtedly will be done in the future. It can be assumed that a reef-type structure such as Leduc should have either an observed or residual gravity anomaly. One may also assume that there are more Leducs as yet undiscovered. Gravity meter surveys should, furthermore, be particularly efficient in the foothills strip. In the final analysis, the seismograph will be called upon to actually make the detailed survey maps which will serve as a guide for drilling. Both the Leduc and Pincher Creek structures were mapped by seismograph.

Only a few of the many advantages of working in Canada have been related here. The American oil company and the independent producer may well consider that in many respects he has all the advantages of home. He will be working with friendly people and under the control of a friendly government. The people literally, as well as figuratively, speak our own language and remind one of the people in our own Western States where the aggressive pioneer spirit still exists.

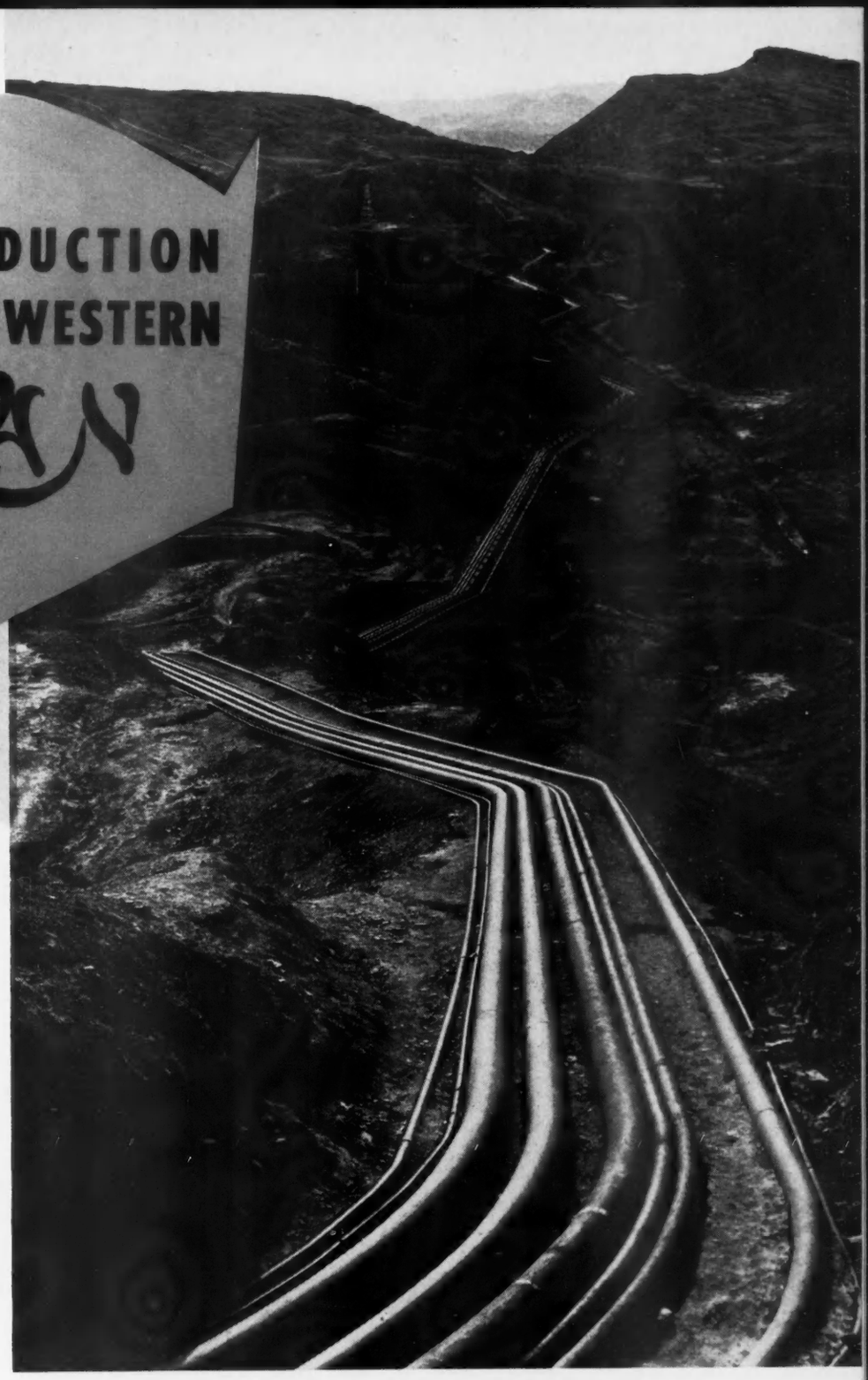
It may be that the time has come when, for oil men at least, Horace Greeley's famous admonition should be paraphrased to "Go North, young man, go North."

About the Author



E. J. HANDLEY was graduated from the University of Oklahoma in 1933 with a B.Sc. in Engineering Physics. The next year was spent in the graduate school at O.U. on the degree of M.Sc. in Engineering Physics. He was with Continental Oil Company from June, 1934, until November, 1943. Most of this time was spent as party chief in charge of a seismograph crew. He spent 1½ years with British American as geophysicist; and 1½ years with Shell Oil Company as seismologist and seismograph supervisor. He joined Century Geophysical Corporation upon its organization as vice president in charge of seismograph field operations.

OIL PRODUCTION IN SOUTHWESTERN IRAN



Part 2

Mechanism of Oil Production

By H. S. GIBSON

Main Pipe lines from Agha Jari oilfield to Abadan, South Iran.

A FAIRLY clear picture of conditions in the Masjid-i-Sulaiman reservoir having now been built up, it was possible to visualize the mechanism by which oil was obtained from it.

When production first began, the crude was initially drawn from the fissures, which in turn drained the fissures in the crestal region, so forming a gas dome in which the pressure was lower than the crude-oil saturation pressure in the porous limestone there. As a result of this lower pressure in the gas-filled fissures, oil would begin slowly to ooze from the rock above gas-oil level. At the same time the loss of pressure in the oil zone occasioned by the replacement of oil by gas in the crest caused a zone or belt of reduced pressure to come into existence immediately below gas-oil level, the depth of this zone being equal in feet of oil to the difference between the saturation pressure at that point and the existing dome pressure. At the lower limit of the zone the saturation pressure and the oil pressure were equal. This lower limit has been given the name of "saturation level." The result of this was that within this zone the oil pressure in the fissures was less than the saturation pressure in the adjacent porous limestone, so conditions existed for oil to be expelled from the porous limestone into the fissures.

As the oil came out of the limestone it was accompanied by bubbles of gas which had been in solution in it, but as soon as they entered the fissure these bubbles migrated upwards to the gas dome. This explains why the fall of dome pressure is so very small. With the slow fall of dome pressure the belt of reduced pressure gradually became deeper (or thicker) and travelled slowly downwards with the gas-oil level. Throughout this zone, oil and gas are being expelled

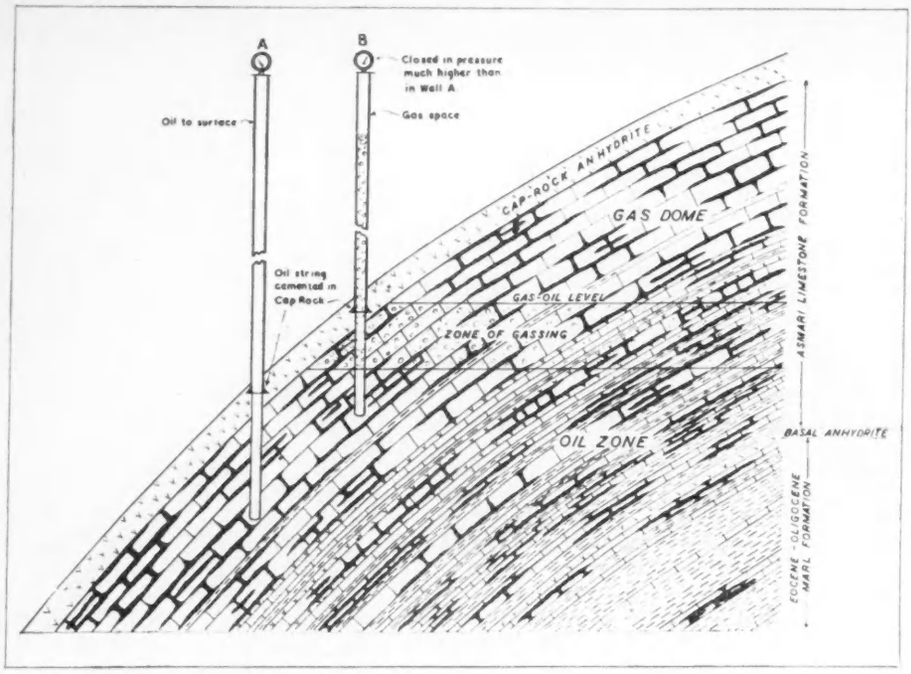


FIGURE 12. Diagrammatic cross section through reservoir on production.

from the porous limestone and it is now some 450 to 600 feet deep. At a rough estimate 15 percent of the gas originally in solution in the oil remains in the reservoir and helps to maintain the dome pressure.

When a producing well is closed down, the casing fills with oil and registers a certain pressure at the well-head. On a number of occasions, however, wells which have previously behaved in this way, suddenly began to fill with gas when closed in and registered a high well-head pressure. This change in behavior is due to the fact that previously they were drawing oil from below the saturation level, but later the saturation level moved down past the bottom of the well and the bubbles of free gas coming out of the porous limestone with the expelled oil happened to be trapped by the well on their upward journey towards the gas dome.

By the time the re-examination of the reservoir rock had been completed and the experiment on the recovery of oil from porous limestone had been carried out, it had become apparent that far from being of negligible value in the production of crude, porous limestone was responsible for the greater part of the production obtained.

Haft Kel Field

A final piece of evidence was provided by the Haft Kel field.

This field began producing in 1930, and by the early part of 1935 had settled down to a steady off-take rate of 16,967,016 barrels a year. Following the installation of new plant, the production rate was then increased within the space of a month or so to 31,335,480 barrels a year. The resultant change in the rate of fall of pressure in the oil zone is very clearly defined, and it is interesting to note that several months, in fact more than a year, was required for the reservoir to settle down to the new rate. This does not look at all like drawing oil from a tank, for in that case the pressure-production curve should have continued along the same path at an accelerated rate. The pressure in the oil zone is the pressure in the fissure system as measured by observation wells. From this curve it is clear that the sudden increase in off-take was initially met from oil in the fissures, and this caused a sudden increase in the rate of fall of the pressure. This then acted as an increased differential pressure on the limestone, which responded very slowly.

Surveying the whole of the evidence now available we can see that there is no firm dividing line between fissures and pore space. On high rates of production some of the finer fissures will behave as pores, while on low rates of production it is quite probable that the most permeable limestone will behave as fissures. It is possible to visualize a rate of production such that only a very limited quantity of oil has time to come from pore space, and from our experience of well No. 245 this rate is not as high as might be imagined. The point at which the open fissures begin to carry a disproportionate amount of the production load is quite sharply defined, and if it is exceeded it becomes almost impossible to control the reservoir, for, as will be shown later, edge water then begins to rise very rapidly.

After the incident of the sudden rise of edge water at Naftak in 1927, no serious difficulties were encountered in controlling the oil-water level for a number of years. Although at first it had been thought that the edge water was not rising, it was later found that there was a small rise amounting to about one foot per month on the average. Some of the water observation wells in the Naftak area and on the northeast flank were

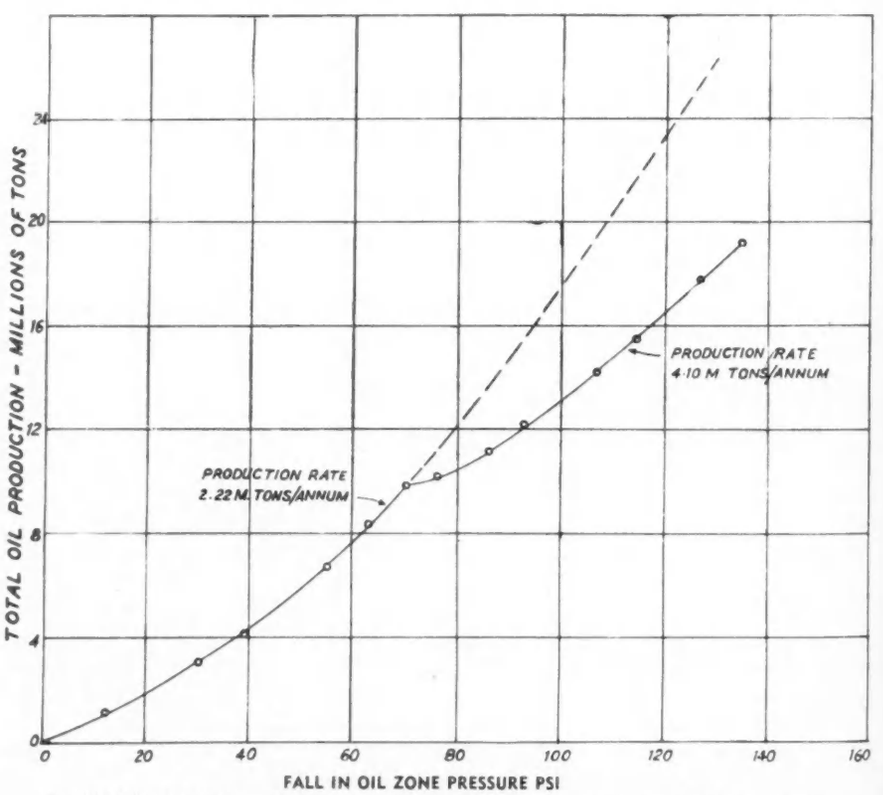


FIGURE 13. Total oil production and fall in oil zone pressure in the Haft Kel field.

sometimes very erratic in their movements but nothing serious happened.

It has already been stated that there must have been a flow of water into the reservoir to make up for the volume of oil lost by seepage, and the most likely place for it to come from would have been via the exposure at Asmari Mountain. The water-observation well nearest to the outcrop is No. B.275 and the record of the movement of oil-water level there, plotted against the pressure in the oil zone is given in Figure 14.

This record is, as far as can be seen, a straight line, and it is interesting to compare it with the rise of oil-water level that could take place under various conditions.

These different conditions are shown in Figure 15. The first is the rise which would occur if there was free connection to an external water table. This is a rapid straight line rise of nearly six feet for each one psi fall of pressure. The second is the rise which would occur if there was restricted connection to an external water table; in this case the line is curved because the rise would be proportional to the steadily increasing differential pressure between the reservoir and the external source. The third is the rise due to a very restricted connection to an external water table. In this case the curvature is so slight that it is almost a straight line, and by comparison the rise of oil-water level in Well No. B.275 (No. 4) may quite well be due to a very restricted connection to an external source.

Pressure Reduction

A fact which must not be overlooked, however, is that a reservoir such as Masjid-i-Sulaiman contains an enormous volume of fluid in porous limestone below oil-water level, and that the reduction of pressure due to production, amounting to an average of about 15 psi per annum, is effective on this fluid. Although the compressibility of fluids is very small, when very large volumes are concerned the effect can be quite appreciable. It is now accepted that the rise of edge water in several oil fields is due entirely to the decompression of water. It is probably safe to say that the slowly rising edge water at Masjid-i-Sulaiman is due to a combination of a very restricted connection to an external source and to the expansion of the fluids in the limestone below oil-water level with reduction of pressure. The word fluids is used in this case instead of water, because in several wells which have drilled into the limestone below oil-water level, rock samples have been found to contain considerable quantities of oil in addition to water. The expansion of both oil and water over the range of pressures concerned is a straight-line effect.

In February, 1937, a well on the northeast flank of the field which was then giving about 7643 barrels of crude per day suddenly began to produce water. A short time before this occurred the off-take from the field had been suddenly increased from 84,071 to 122,285 barrels per day. The result of the proportional increase in the sector concerned was that instead of the normal rate of fall of 1.5 psi per month in the oil pressure there, the fall was 3.75 psi in half a month, equivalent to a rate five times the normal. It was quite clear that the local rise of oil-water level to the producing well was due to the increased off-take which was initially supplied by oil from the fissures only. The rapid fall of the oil column in the fissures caused a similar fall of pressure on the fluids below oil-water level, which expanding under the reduction of pressure caused edge water to rise rapidly in the fissures. The question, which at once arose from this incident, was how a pressure drop of 3.75 psi in half a month caused edge water to rise 200 feet or so, when the same drop at the normal rate of 1.5 psi per month would have caused the edge water to rise only 2.5 feet.

The reason would appear to be that at the normal slow rate of rise, the water has time to enter minute fissures and porous limestone and displace crude, and that when the rise is rapid there is no time for this to take place, and the water being confined to the small-volume fissure system has a greatly magnified effect.

The well which produced the water was shut in for four months and then reopened to production, being then absolutely free from water, and the oil-water level had returned to its normal position.

This incident showed very clearly that a sudden increase in rate of fall of pressure at oil-water level must be avoided, and the rate of increase of off-take from Masjid-i-Sulaiman was therefore limited to 20 percent in one month.

The displacement of crude from porous limestone by water has been examined experimentally. It was found that, as expected, a differential head was required to initiate the flow of water into oil-filled limestone, the head depending upon the porosity of the sample under test. The quantity of oil displaced, however, seems to be more or less a constant proportion of the total oil in the limestone, amounting to something between 10 and 15 percent. It would therefore seem to be less efficient than the recovery by dissolved gas drive.

There also seems to be the risk that, if the fissures in which the water rises are widely spaced, large masses of limestone may be completely submerged before the displacement of oil is complete, unless the rate of water rise is very slow. On the other hand, if the limestone is well fissured, complete blocks of it may be submerged before sufficient differential has been created to initiate the flow of water into the pores. Once a block of limestone is completely submerged by water there can be no further increase of differential, and therefore displacement of oil by water in production time is very unlikely. Samples of porous limestone obtained from well below oil-water level have always had a considerable oil content.

During the course of routine observa-

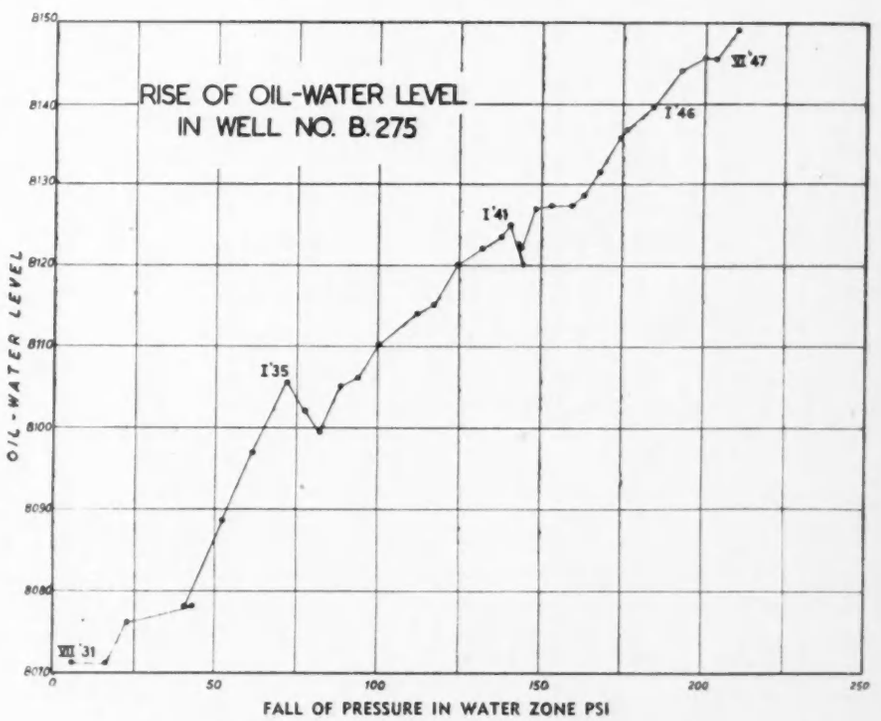


FIGURE 14. Rise of oil-water level in Well No. B. 275.

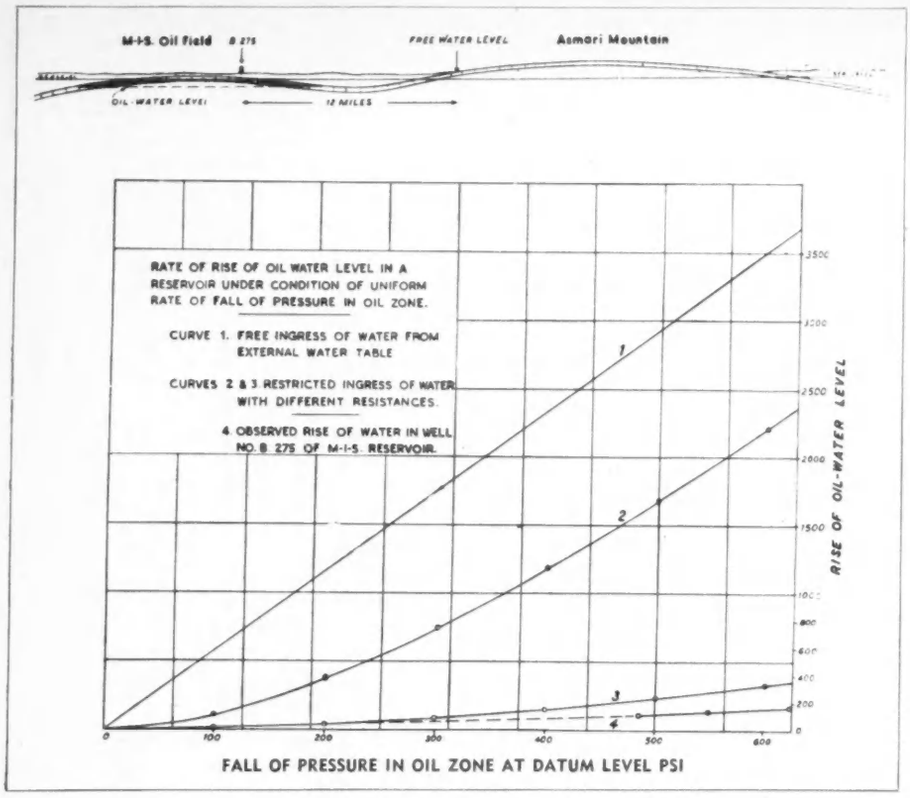

M-I-S. Oil Field
B 275
FREE WATER LEVEL
Asmari Mountain
OIL-WATER LEVEL
12 MILES
RATE OF RISE OF OIL WATER LEVEL IN A RESERVOIR UNDER CONDITION OF UNIFORM RATE OF FALL OF PRESSURE IN OIL ZONE.
CURVE 1. FREE INGRESS OF WATER FROM EXTERNAL WATER TABLE
CURVES 2 & 3 RESTRICTED INGRESS OF WATER WITH DIFFERENT RESISTANCES.
4 OBSERVED RISE OF WATER IN WELL NO. B 275 OF M-I-S. RESERVOIR.
RISE OF OIL-WATER LEVEL
FALL OF PRESSURE IN OIL ZONE AT DATUM LEVEL PSI

FIGURE 15

tion on the oil-water level in Well No. B.275, it was found that the temperature conditions were abnormal. It was ultimately discovered that edge water was flowing into the well through a fissure about 110 feet below oil-water level at the rate of 1000 gallons per day, and out of the well through a fissure 155 feet lower down.

Figure 16 illustrates what can happen in a reservoir. Obviously the upper fissure belongs to a much more extensive system than the lower one, but the lower one is in contact with a considerable volume of porous limestone.

It is strange that in the most fractured part of the reservoir there should be an interval of 155 feet between fissures, and that these fissures are apparently not connected to each other except possibly at a higher level. Throughout the Bibian sector the average distance drilled into the limestone by the producing wells before obtaining satisfactory production was 70 feet, and there are indications that the distances between fissures increase with depth. The occurrence of fissures appears to be completely fortuitous; several attempts have been made to correlate them, but without the slightest success.

Fissures Important

Although it has now become quite clear that porous limestone is responsible for the greater part of the production and that the quantity obtained from fissure space amounts probably to something of the order of 10 percent only, the importance of the fissures must not be minimized, because without them production would be impossible. The Bibian sector of Masjid-i-Sulaiman is far more fissured than any other part of the field, and its productivity is greater than any other, that is, within the time and at the rate that oil has been produced from the field. The oil in the limestone at Bibian has a shorter distance to travel to a fissure, and therefore it comes out more quickly. In the less-fractured sectors of the northeast flank it takes longer and therefore these sectors are much more sensitive to increases in the rate of production, because the porous limestone does not react so quickly as it does in Bibian. In Babian the ratio of pore space to fissures is less than on the northeast flank. The production allocation to sectors is based on what they produce under steady conditions; if it were based on pore space the Bibian allocation would be less and the northeast flank more; if it were based on fissures Bibian would be more and the northeast flank less. During an increase in the production rate the allocation should be based more on fissures, since the initial increase has to be carried by the stock in fissures, and therefore a greater amount drawn from Bibian and less from the northeast flank. This is exactly what has been found in practice. Although the rate of increased off-take from the whole field has been limited since 1937 to 20 percent in one month it was found better to draw most of this in the first place from Bibian and then slowly transfer the correct proportion to the northeast flank as the field steadied down to the new conditions. The reverse arrangement is required on reduction of throughputs, but as there are no ill effects attached to a reduction no such action is taken. It is noticeable, however, that on these occasions the northeast flank sectors build up

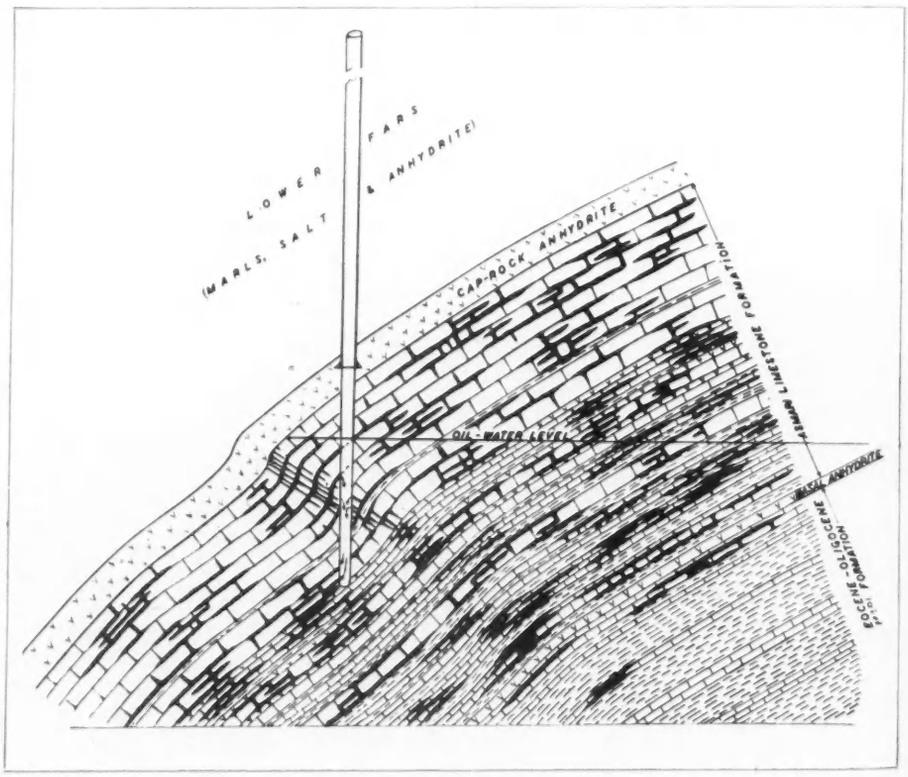


FIGURE 16. Diagrammatic cross section through part of reservoir to explain downward flow in water zone as in Well B. 275.

their gas-oil level more rapidly than does Bibian.

During the war it became necessary, owing to shortage of pipe, to shut down some of the production sectors on the northeast flank for a few years, and the uniform-pressure system of control established after the rise of water at Naftak in 1927 was no longer maintained. The pressure on the northeast flank was for some time about 25 psi higher than on the southwest flank. At one time this would have been regarded as a rather risky proceeding, but experience over the intervening years had shown that it was not the out-of-balance pressure which caused the trouble, but a high rate of pressure change which was dangerous. There is no real need therefore to maintain a uniform pressure and uniform gas-oil level over the whole field, but doing so has the advantage that it makes rate of change of pressure easier to control, and, by preventing migration of oil from one sector to another, allows the relative productivity of the various sectors of the reservoir to be measured and so is of great help when estimating reserves.

Consideration of the rate of pressure change permissible in a field brings up the question of the optimum and maximum rates of production. Referring to Figure 13 it would appear that at Haft Kel producing at 16,967,016 barrels a year was more efficient than producing at 31,335,480 barrels, because if production had continued at the lower rate it seems fairly certain that an additional 49,678,200 barrels of oil could have been obtained from the same pressure drop that gave a total of 126,106,200 barrels at the higher rate. Part of this 49,678,200 barrels would belong to porous limestone left behind by the more rapidly falling gas-oil level at the higher rate of production, and would undoubtedly be produced in course of time; it could therefore be regarded as deferred production. The remainder, being production from oil-water level, would be more likely to be lost, because if an appreciable part of the water rise was due to decompression, the rise would be more rapid and there would be less time available for this additional amount of water to displace crude in porous limestone, and so some crude might be lost.

At high rates of production it appears that the rate of reduction of pressure on the edge water causes the latter to rise at such a rate that it hardly has time to enter porous limestone at all, and one gets the impression of a rather unstable condition. If sudden increases in off-take are made with a reservoir in this state there are almost certain to be sudden and erratic rises of edge water. This condition was experienced at Haft Kel during the war when off-take from that field was at its maximum.

The maximum rate of reduction of pressure that a field will stand is dependent entirely on the degree of connection to an external source of water supply and to the total amount of fluid below oil-water level subject to the reduction of pressure, both items being considered in relation to the nature of the fissure system, which, if small, is not in contact with sufficient oil-filled porous limestone to accommodate the rising water within a reasonable time.

Assuming that oil left behind above gas-oil level is deferred production and will eventually be obtained, the optimum and maximum rates of production for a field depend upon the rate of rise of edge water. If the rate of rise of edge water is fairly slow and uniform (such as the rate of 1 foot per month at Masjid-i-Sulaiman) and there are no sudden erratic movements, then the rate will not be far removed from the optimum. If, on the contrary, edge-water movements are erratic but are not subject to a general rapid rate of rise, it can be assumed that it would not be safe to increase the off-take beyond that amount.

For two reservoirs having approximately the same amount of recoverable reserves and the same edge-water conditions, but the one having a deep oil column and covering a smaller area, and the other having a shorter oil column and covering a larger area, the latter would be able to produce at the higher rate, because for a given production the reduction in height of oil column would be less, with a correspondingly smaller rate of reduction of pressure on the edge water.

Provided the rate of production is such that the oil-water level rises at a reasonable rate the only other limitation is the permeability of the limestone. Experience at Masjid-i-Sulaiman suggested some years ago, but without any real evidence to support it, that the off-take from the field should not exceed 5 percent per annum of the remaining recoverable crude in the reservoir. This seems to have worked very well, but the great difficulty in applying it is the estimation of the remaining reserves. The slower the rate of production the greater seem the reserves, as Figure 13 indicates, and vice versa.

To adhere precisely to such a rule is not economic, because it involves building up to a peak rate and then almost immediately beginning to reduce. In actual practice the field would be brought

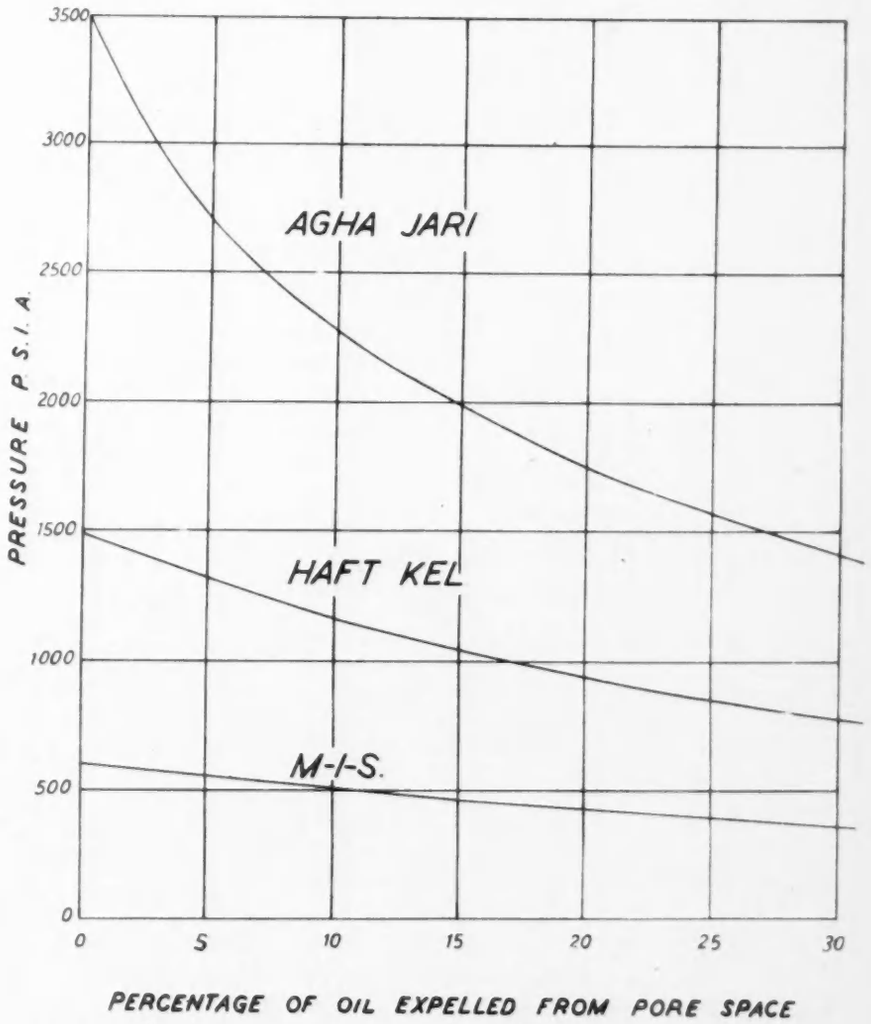


FIGURE 17. Calculated expulsion of oil from porous limestone with fall of pressure.

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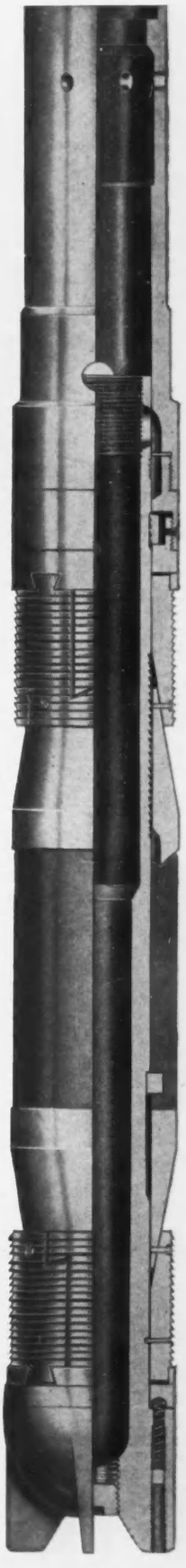

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up to 3 or 4 percent of its estimated ultimate yield and then maintained at this steady rate for ten years or so until the rate is equal to 5 percent of the remaining recoverable crude.

In describing conditions in the Masjid-i-Sulaiman field in 1927 it was stated that the value of gas conservation was fully appreciated and that the pressure in the gas dome was falling less than two psi per annum; it was later explained that the dome pressure was maintained with gas which had been expelled, together with oil, from porous limestone. For this oil and gas to come out of the porous limestone it was essential that the pressure in the fissure system should be lower than the saturation pressure of the oil in the rock, and yet the gas which collected in the dome and maintained the pressure there was also maintaining a similar pressure throughout the fissure system. The maintenance of the dome pressure is therefore preventing oil and gas from coming out of the porous limestone into the fissures. Instead of being allowed to collect in the dome and thus hinder the production of oil the gas should be produced with the oil to which it belongs. The gas-oil ratio of the crude coming from porous limestone is approximately 45 to 1, and the average gas-oil ratio of the crude arriving at the surface at the present time is about 35 to 1. The other ten volumes are collecting in the gas dome. It is not physically possible to produce the whole of the gas which belongs to the crude with the crude, but that is not necessary, for all that has to be done is to produce sufficient gas from the dome to bring the overall producing gas-oil ratio up to 45 to 1. It is estimated that during the producing life of Masjid-i-Sulaiman about 15 percent of the gas originally in solution in the crude produced from porous limestone has been collected in the gas dome.

Recovery Methods

Within the last 30 years considerable progress has been made in the improvement of the recovery of oil from sand reservoirs. Three different mechanisms are now generally recognized:

(1) water drive;

(2) gas cap drive;

(3) dissolved gas drive.

They are here given in the order of their efficiency. Both water drive and gas cap drive require a sand of high uniform permeability to reach their greatest efficiency, and even then the rate of production must be restricted to something like 3 or 4 percent of the estimated ultimate recovery, otherwise by-passing and channeling take place with consequent non-recovery of oil.

It is clear that neither of these mechanisms would be very efficient in the limestone reservoirs of Southwestern Iran with their enormous range of permeability, the range being from the infinite permeability of the fissures to that of the lowest porosity limestone. Although experiment has shown that some 10 to 15 percent of oil in place can be recovered by displacement with water, the fortuitous nature of the fissuring would almost certainly prevent even this small recovery being effective over all the limestone submerged by rising edge water.

It is also clear from the effect of gas accumulation in the gas dome described above, that the injection of gas to apply gas-cap drive to these limestone fields would not only be of no assistance, but would definitely reduce the amount of oil obtained, because it would put a back pressure on to the limestone surfaces of the fissure system.

It will be recognized that the production mechanism of Masjid-i-Sulaiman is mainly dissolved-gas drive, with gravitational drainage from the fissures at gas-oil level and water drive in the fissures and porous limestone at oil-water level as subsidiaries.

What will happen in the future in the fields of Southwestern Iran it is impossible to say, as none of the reservoirs there has as yet approached the end of its producing life, and we have therefore nothing to guide us.

The efficiency of dissolved gas drive in sand fields never exceeds about 25 percent recovery of oil in place, the more usual recovery being 15 to 20 percent as in the experiments of Figure 10. In the sand fields, however, the rate of reduction of pressure has invariably been far higher than the rates in the fields of Southwestern Iran and it may be that in the latter the recovery may exceed 25 percent.

The conditions limiting recovery is that when gas bubbles in the pores of the limestone link up and form a continuous gaseous path along which all gas subsequently evolved from solution passes to an open fissure without pushing any oil ahead of it.

It was mentioned previously that the saturation pressure inside a mass of limestone (and therefore remote from an open fissure) might be appreciably higher than in the neighboring fissures. If this should be the case, reduction in pressure would cause bubbles to be formed first of all at the point of highest saturation pressure inside the limestone and thus give a higher efficiency of recovery.

In order to achieve maximum recovery a greater reduction of pressure is required in the higher pressure reservoirs as shown in Figure 17.

In conclusion, it must be emphasized that no two oil fields are ever exactly alike. In these limestone fields the amount and variation of fissuring, the arrangement and occurrence of the various types of limestone, the edge-water conditions, and the saturation pressures of the crude, all affect the production mechanism and recovery of oil. An adequate number of observation wells by which the gas, oil, and water pressures and levels can be recorded is essential for the efficient control of the field, and to enable unforeseen occurrences to be quickly diagnosed and remedied.

H. S. Gibson, General Fields Manager, Anglo-Iranian Oil Company, Ltd., is presented with the Institute of Petroleum's "Redwood" Medal by the president, Sir Andrew Agnew, at the Institute's meeting on March 10.

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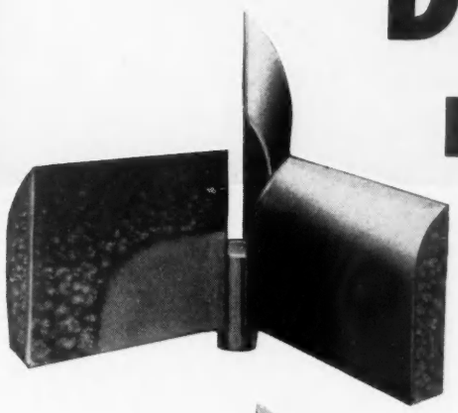

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Turkey Plans

Vast Drilling Program

Acme Photo.

Turkey's President Ismet Ionu (center right, wearing cap and military boots) looks on with other officials and American contractors as the nation's first commercial well flows into the pits.

TURKEY is planning a vast and intensive drilling program throughout a wide oil-favorable area in the southeastern part of the country, near the Iraqi border, according to plans announced to WORLD OIL by Ihsan Ruhi Berent, general director of Turkey's state petroleum agency, Maden Tetkik ve Arama Enstitutu (MTA). The stepped-up drilling schedule follows confirmation by the Mining Research and Exploration Institute of the discovery of a commercial quantity of oil in the Ramandag Anticline. This is the first successful postwar test drilled by the Institute and it was reported swabbing about 500 barrels daily of 15-degree gravity oil, at a depth of around 4400 feet.

MTA has been drilling in various parts of Turkey but the work has been accelerated in the Ramandag Anticline during the last two years. Further immediate efforts will be concentrated in this area and Berent says, "Our Institute geologists are expecting considerably more oil in the deeper horizons."

The present discovery, Raman 9, is not the first time oil has been found in the anticline, but it has received widespread attention throughout Turkey because of the visit to the well by Turkish President Inonu on March 3. Raman 1 struck oil in 1940 and flowed initially 70 barrels a day, but soon went to water. Other less successful tests followed until Raman 5 came in with a steady flow of ten to 12 barrels a day for two years. Raman 8 was drilled still later and is now giving 25 to 30 barrels daily. The latest discovery, No. 9, was expected to treble its current rate when put on the pump.

The drilling has been done by Drilling and Exploration Company of Dallas, with the company's vice president, E. H. Clayton, directing operations on the ground. Four rigs and drilling crews have been sent to Turkey, following widespread exploration in a number of scattered areas. This exploration work has been carried on for nearly two years by United Geophysical Company, which still has one geophysical crew operating and is cooperating with another all-Turkish crew now at work.

Oil's Antiquity

Although production is still slight in Turkey, MTA points out that the oldest known oil records in the world refer to what is now Turkish territory. The statue of the Sumerian King Adab, now in the Instanbul Museum, contains bitumen in the eye-sockets, and some 2000 years later Queen Semiramis, about 700 B.C., is credited with having built a tunnel under the Euphrates lined with burnt brick and coated with asphalt as mortar. In the Seventeenth Century, A.D., the Turkish traveler Evliya Chelebi writes of oil seepages in eastern Turkey which were gathered and sold to townspeople for medicinal and other purposes.

Modern drilling first began in Turkey about 50 years ago on a concession held by a British-German group which put down ten shallow wells and obtained strong shows of gas and oil but later abandoned the enterprise.

Oil Accumulations Reported In Fezzan Region of Libya

It has been reported from Algiers that French technicians have discovered oil accumulations in the Fezzan region of Libya, south of the Oasis of Murzek. No details are available regarding the nature of the showings. The area mentioned is near the Algerian frontier in a zone occupied by the French since the end of the North African campaign in 1944.

Recently a strike had been reported in the Petitjean area of French Morocco, which gives promise of being the area's most important discovery.

FRENCH WORKERS WITH ARAB HELPERS.

CLEANING PIPE ON IPC'S NEW LINE.

Iraq's Kirkuk Outlet

IRAQ Petroleum Company will proceed with the laying of the north leg of its 16-inch pipe line from the Kirkuk fields to the Mediterranean, despite political disturbances which are delaying indefinitely completion of the south leg. Decision to go ahead with the line indicates an attempt to open at least half the new system by early 1950, a year behind the original schedule. IPC plans to string pipe on the north leg, from Kirkuk to Tripoli, Lebanon, in September or October at latest. Deliveries of the pipe, which is being rolled in England and in France, are far behind program, but first shipments are expected by summer, and thereafter work will proceed westward from K-3, the system's bifurcation point at Haditha on the Euphrates River, through Iraq and Syria.

Meanwhile, all but 68 miles of the 620-mile south leg of the new line is in the ditch, but there will be no effort to complete the remaining short stretch through Palestine until the Arab-Jewish political trouble subsides.

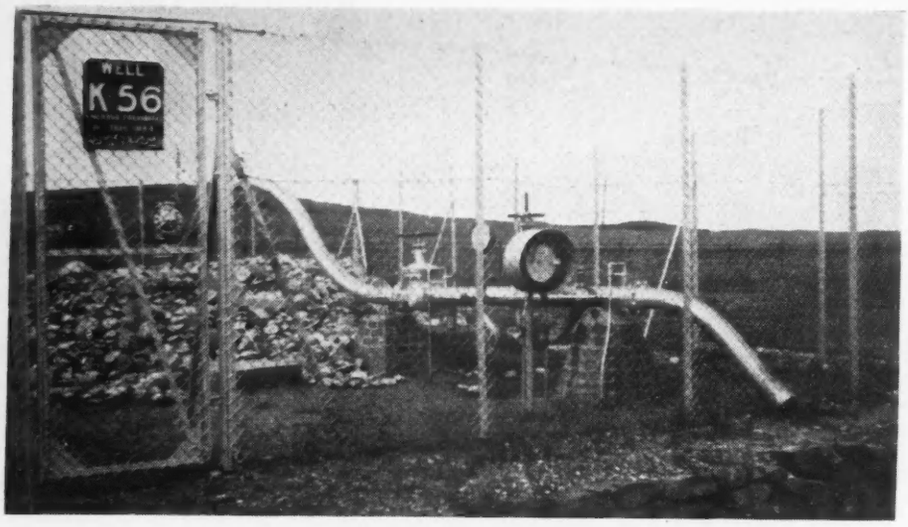
The new 16-inch northern system will parallel the existing 12-inch system and will tie into the 12 pump stations already strung across the desert. A total of 172,000 tons of pipe is required for the new project, of which 80,000 tons will be needed on the north leg of 530 miles.

Operations Suspended

Virtually all IPC operations have been suspended in Palestine and the entire headquarters personnel of 200 persons at Haifa, terminal of the line's south leg, have been transferred to Tripoli. In addition, the Consolidated Refinery at Haifa, which has been processing the 46,000-barrel-a-day tender from the south leg of the pipe line, closed down April 13 when the plant was seized by the Jews and Arab labor was barred. Closing of the refinery caused IPC to stop pumping through the south line, and shortly afterwards a strike of 8000 Arab workmen in Syria and Iraq shut down the north leg. Thus for the first time since the line went into operation in 1934 the flow of its 92,000 barrels a day to the Mediterranean was interrupted indefinitely. By mid-May it was announced from London that the strike difficulty had been settled and the north line would resume pumping.

The IPC system is currently the only pipe line carrying oil from the Persian Gulf area to the Mediterranean and the curtailment of its throughput is seriously affecting oil supplies. The populous Levant region and Cairo fear an "oil famine" if the pipe line is unable to maintain capacity operation. The British *Economist* saw further that "the lack of fuel may work more effectively than anything else to determine the shape and course of the Palestine war."

Also, the revenues of the Arab states are hit drastically by the line's failure. A large part of Iraq's budget comes from



IPC's No. 56 at Kirkuk, first of the postwar wells.

oil royalty—about $1½ million yearly—and that amount was to have been doubled with the opening of the new 16-inch line. IPC is the largest private employer in the Middle East now and troubles on the line have caused the temporary laying off of thousands of workmen.

Both U. S. and British oil interests in the Middle East believe that a solution of the Palestine war may be reached through King Abdullah of Transjordan. Abdullah during May became the "strong man" of the Arab League because he maintains the only modern and effective military force east of Suez. With the collapse of the Arab volunteer army in Palestine, it was clear that Arab resistance to Jewish forces would have to be exerted through regular armies, particularly through the power of Abdullah. This was distasteful to several of the Arab League states, especially to Lebanon and Syria, because for the past three years Abdullah's "Greater Syria movement" has been aimed at the unification of Lebanon, Syria and Palestine under the King of Transjordan. Lebanon, the only Christian-majority nation in the Middle East, fears Moslem domination under Abdullah's hegemony, and Syria fears practically loss of her independence. Abdullah himself is known to be dissatisfied with the landlocked character of his kingdom and desires a Mediterranean port, which presumably he might carve out of Jewish Palestine.

Petroleum interests may be affected favorably because of the closer alliance between Abdullah and Iraq. Iraq is dependent on and quite sympathetic to IPC's problem. Abdullah certainly would support any Iraqi position in the present war. Further, Transjordan itself went under a blanket exploration concession to IPC last summer and Abdullah is known to be eager for the company to start work in the kingdom.

It is considered likely that if Abdullah disturbs the present map of any of the Middle East countries, he likely would act to protect IPC rights and facilitate completion of the new pipe line.

Meanwhile IPC has taken first steps toward construction of a pipe line from Transjordan to the Palestine port of Haifa. This action indicates IPC may be planning to start drilling operations in Transjordan soon. The company has applied to the Palestine government for permission to lay the line, and a British communication to the United Nations Palestine Commission discloses that the British government has authorized the Palestine government to grant the franchise for the line. This authorization virtually assures the award of the transit rights.

Transit Rights Obtained

IPC says there is no plan to build the line in the immediate future, but that Palestine transit rights are being obtained as a precaution against the day when the line may be needed to transport oil from Transjordan to the Mediterranean. This line would be the third IPC system crossing Transjordan. In 1934 the company opened its 12-inch line from the Kirkuk fields in Iraq to Haifa, and a second branch from Kirkuk to Tripoli, Lebanon. Now IPC is laying a 16-inch line paralleling the original system. Pipe already has been laid along the south leg of the new line through Iraq and all the way across Transjordan to the Palestine border. While Palestine transit approval for this 16-inch line was obtained some time ago, there is a report that the line's completion through Palestine may wait on the settlement of current political disturbances.

IPC officials point out that it would be possible to pick up Transjordan oil with the 12-inch or the 16-inch system for delivery to Haifa, although this would prevent capacity loading of the line at the Kirkuk fields. Therefore, it has been decided to construct the third line when and if production begins in Transjordan. The third line also may be necessary for legal reasons; existing transit agreement with Palestine could limit the use of either the 12-inch or the 16-inch line across Palestine to oil originating in Iraq.

Last May IPC obtained a blanket exploration concession covering Transjordan. Exploration has been under way there although no drilling has taken place. However, the company agrees to pay Transjordan an annual fee of $180,000 for transit rights when the new line is laid.

The action of London in ordering its Palestine administration to grant the transit rights for the third line is considered unusual since Britain has announced it will turn back the Palestine mandate to the United Nations on May 15. IPC had been in negotiation with the Palestine government for the rights, but these negotiations were suspended last January because of "impending constitutional changes." In effect, the London decision overrides the Palestine Administration. This is taken by many industry observers to mean either that Britain plans to continue in Palestine after May 15, despite all statements from London to the contrary, or that London is attempting to bind the future Palestine regime in order to assure transport of oil from Transjordan.

Australasian Petroleum Selects Three Wildcat Sites in Papua

The Australasian Petroleum Company has selected three locations for wildcat drilling in Papua following the abandonment of its deep test at Kariava, which had reached 12,621 feet.

The new locations, on which preliminary construction work is already in progress, are at Upoia and Hororo on the Vailala River, about 25 miles and 30 miles south of Kariava, respectively, and at Oroi, about 50 miles northwest of Port Moresby. The Kariava location was about 80 miles northwest of Port Moresby.

The rig from the Kariava test, already being dismantled, is to be used on one of the new locations, while equipment will be moved in for the other two, so that all three are to be drilled simultaneously.

Australia's Prime Minister has announced that Australia is arranging to supply equipment to help increase oil production in the East Indies. Australia is also quite interested in the progress of the exploration of Papua, particularly in view of the chance for possible interruption of Middle East supplies as a result of the present troubles in Palestine.

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Russia May Renew Drive for *Iran's Oil*

RECENT increased criticism by Russia of the American Military Mission in Teheran indicates that Moscow may be preparing a new and more powerful diplomatic drive on the Iranian government for concession rights in the five Northern Iranian provinces. Since Iran's Parliament last October refused to ratify the previously negotiated concession with Russia, Teheran is forbidding any further exploitation of her petroleum resources by outside interests. The new policy does not affect the existing operations of the Anglo-Iranian Oil Company, however.

Piecemeal reports from the Soviet Union show that Russia is faced with a serious petroleum crisis. It now appears that unless Russia gains control of new oil-producing areas (presumably in Iran) the whole Russian rehabilitation scheme as well as the Five-Year Plan are threatened. Signs of the oil squeeze have been evident in Russia for several months—the strict economy demanded of every consumer of petroleum products, and the increasing use of natural gas for heating and lighting, as well as the construction now under way of several synthetic plants.

It is generally admitted that the Soviets' oil production schedules are falling far behind. As part of the program for Soviet Azerbaijan, newly prospected oil beds are to be developed at Baku and Grozny. Deep-drilling methods have been introduced with the intention of sinking wells to 16,000 feet.

There are several reasons for the oil difficulties in which Russia now finds itself:

1. War damage is still considerable. It is estimated that 3000 oil wells at Krasnodar (Maikop) and Grozny which were badly damaged during the war are only partly rehabilitated. Damage is still considerable at the refineries at Grozny, Odessa and Kherson, and to many storage installations and pipe lines.

2. The Baku fields, Russia's richest, are showing a sharp decline in production. Development of this area for about 75 years, together with the abnormal war strain on the field, and with virtually no additional development drilling, are responsible for the plight at Baku. Recent admission by an expert for the State Planning Commission was to the effect that during 1941 and 1942, more than 1000 wells closed because of transportation problems, while "an even greater number of wells had to close down for lack of repair crews and replacement parts."

The same Russian authority estimates that only 63 percent of Russia's program for exploratory drilling was carried to completion in 1945 and only 67 percent in 1946. Total Russian production in 1945 is put at about 383,000 barrels daily, and in 1946 at 429,000 barrels daily.

Oil Center

While there are still large deposits of oil in deeper formations and under the Caspian Sea offshore of the Aspheron Peninsula, Russian technology is not yet able to handle the methods necessary for this development. However, the government has been transforming the port of Makhatch Kala, on the Caspian northwest of Baku, into the country's biggest oil port. This would be a logical center for the distribution of petroleum northward toward Astrakhan and up the Volga to the industrial regions of the interior.

3. Russia's new fields so far have disappointed. This is particularly true of the area between the Volga and the Urals, known as "the second Baku." The quality of the crude here and the rate of production have been decidedly inferior to the Baku fields.

4. The Soviet Union's stepped-up industrialization program has been requiring oil at a rate not adequately provided for. Intensification of transport, mechanization of agriculture, industrial relocation, etc., are using oil faster and in much larger quantities than expected.

In the face of these rising requirements, it is considered unlikely that Russia's internal production will increase appreciably in the near future. The Five-Year Plan calls only for doubling by 1960 the prewar output of 30 million tons of petroleum.

These considerations are at play in the expected Russian moves against Iran. Even with her added oil resources acquired from Roumania, Poland and Hungary, Russia has increased her resources by only about 7½ million tons annually. The five Northern Iranian provinces, which Russia once believed would be her oil property by concession, would go far toward making up the deficiency of the next 20 years. Production in Iran would be more advantageous to Russia than in any other non-Soviet area because transportation, refining and distribution problems would be held to a minimum. Oil produced in Northern Iran could be brought from Bandar Shah, the terminal of the Trans-Iranian railroad, via the Caspian Sea to Baku. The crude could be refined there where plant capacity is now in excess of local production, then products could be shipped to Stalingrad or by existing pipe lines from Makhatch Kala into the industrial areas of the Ukraine.

French Government to Drill Wildcats in New Caledonia

The French Government has been carrying out extensive geological investigation for petroleum possibilities in the Pacific colony of New Caledonia, and it is now reported that wildcat drilling is planned as soon as equipment can be moved in.

Oil seepages have been known for more than 50 years in the neighborhood of Koumac, near the northwest end of New Caledonia. These seepages occur in a porous serpentine mass. The Eocene beds which cover a large part of the island also include bands of bituminous limestone and there is a very promising anticlinal structure in the vicinity of Bourail, halfway down the western coast. Shallow drilling down to a depth of 500 feet has confirmed the structure as being of potential value for oil prospecting.

February Production in Iran Reported by Anglo-Iranian

Anglo-Iranian Oil Company, Ltd., has reported its production from Iran oil fields at 12,373,693 barrels for the month of February, bringing the total for the first two months of the year to 25,595,737 barrels. This is at a rate approximating the producing rates of 1947 when total output for the year was 154,861,000 barrels for the entire year.

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Quiriquire Strengthens Position as Important Reserve

By GEORGE O. IVES
International Editor

QUIRIQUIRE, the first of the Eastern Venezuela oil fields, now in its twentieth year of continuous production, has again strengthened its position as the most important reserve in the eastern part of the nation. During the period since 1928, it had produced more than 278 million barrels of oil, or approximately half of the amount estimated to be the recoverable reserve of the structure. Now, as a result of development during 1947, entirely new reserves have been found, mostly within the same areal limits as had already been proven in the field, which are thought sufficient to double its already substantial reserve.

Actually there has been some relatively slight extension of the proven area to the north and to the east, but the major portion of the so-called new reserve is in deeper members of the same pay as that from which the field has been producing for the past 20 years.

As a result of this new production, the field and camp operated by Creole Petroleum Corporation is beginning to again take on all the aspects of a new operation, although with many advantages not normally available to a new field in remote sections of foreign countries. Before the new drilling campaign started the industrial area of the camp was already well equipped with machine shops, housing facilities, offices, warehouses, schools and all other features which go to make up a typical Venezuelan oil field headquarters camp. An added advantage was that inasmuch as the area receiving most of the new drilling lies largely within the area which had been developed during the past 20 years, there already existed a complete system for gathering, handling and transporting crude oil. It is only necessary to add to these facilities from time to time as new wells come on production.

Road Problem

At the same time, a network of field roads already existed in the area, from which secondary roads could be built to the new locations as they are selected and drilled. The matter of roads is of no little importance in this particular field, since the rugged character of the terrain is such that roadbuilding is tedious and expensive. Very seldom is it possible to build a continuous road lateral to service more than one or two wells. The field is situated in the foothills of the northern range of mountains not far from the town of Maturin. Although the hills have comparatively little relief as compared with the valleys—no more than 100 to 200 feet through most of the field—they are extremely broken and covered with dense tropical forest. A location no more than a few hundred feet from one well might have to be approached from an entirely different direction unless a major job of earthwork is to be undertaken. Consequently, although the field covers a comparatively small area of perhaps 11,000 acres, there are nearly 200 miles of road. Another index of the nature of the terrain may be taken from the fact that in the entire gathering system in use in Quiriquire field, one joint of pipe out of every four is a bend.

The principal machine shop for the entire Eastern Division of Creole Petroleum Corporation's Venezuela operations is located at Quiriquire. New construction planned, now that the field has taken on added importance, includes a new club building for employes and a 200-bed hospital for which site has already been cleared and on which construction is ready to begin. In the field itself a new repressuring plant has been completed and injection wells prepared, but the plant is awaiting completion of new capacity in the Caripito power plant before it starts operation since it is designed to use three-stage compression powered by electric motors.

Quiriquire field itself is a strange reservoir. The producing formation, instead of being obviously sedimentary in nature, is more in the from of an alluvial fan of material washed down from the mountains to the north and collected at this point to form a trap of Pliocene age, largely stratigraphic and faulted. The sediments do not appear to be marine in origin and all seem too young for the accumulation. Boulders have been cored in the producing section which, judging from the curvature of the face, would be three or four feet in diameter, and the entire section consists largely of these boulders, ranging from the larger ones on down to pebble size. It seems to be more like an old river bed than a sedimentary deposition. Although never confirmed by drilling, it is possible that the

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oil might be coming from older beds below. In comparatively recent months, one or two wells have been completed in deeper sands which might prove to be Eocene. If so, this would be the only field in Eastern Venezuela from which oil may be produced from the Eocene.

Production Has Increased

During the past year and a half, production has increased from some 47,000 barrels daily at the end of 1946, to 70,000 barrels a day at the end of 1947. Total production for the year was just under 20 million barrels. Average gravity of the crude oil from the field is about 18.5 degrees, API, and although it would be possible to transport an excess back through the pipe line system which connects with the Jusepin, Mulata, and other fields to the southwest, and on to the terminal at Puerto la Cruz, all of the oil goes by pipe line to Caripito refinery and to terminal storage and is shipped through the port on the San Juan River. The greater part of the crude is refined in the Caripito refinery, products being loaded on tankers at San Juan for the trip down river to the Gulf of Paria, between Venezuela and Trinidad, and on out into either the Caribbean or the Atlantic depending on destination of shipments. About 15,000 to 20,000 barrels daily is shipped out as crude oil, most of it going to Canada. None of Quiriquire's crude oil is exported as such, but is mixed with crude from Jusepin field to form a blended crude called "Monaca," for which there is considerable demand.

The new production is not actually new in the sense that it is a different formation or even a different member of the same formation. While the early drilling of the field was in progress, no dry holes had been drilled on the north and east end to define the extent of production. Drilling had not continued out because it was found that less net sand was being recovered in normally drilled wells on that end, so development was stopped in that direction while attention was being given to fill-in drilling on top of the structure. Recently, one of the new wells in the east end of the field went on down through the section and found that the pay formation cleared up again below the broken portion which had been presumed to limit the field, and much more pay section was found than had been found on top of the field. The development has continued out pretty well along the strike, so that depth of the newer wells is not much greater than in the older part of the field.

With opening of the newer production the operators have gone back into older parts of the field and drilled deeper wells, finding more section here also. Now a more orderly attempt is being made to properly evaluate the potential of the area. Although comparatively few dual-zone producers have been drilled, there is a widespread practice of drilling twin wells to different, separated sands.

At one point, in the eastern end of the field, a group of four wells has been drilled in line, just the width of the derrick legs apart, so that one service derrick, rolling on a truck, can be spotted within a few minutes over any one of the four holes. These wells are completed in sands as shallow as 2000 feet and as deep as 5000 feet, taking in almost the complete section which exists in the field at that point. By drilling four wells, it was felt that performance of any sand could be observed at this one point where most reservoir conditions would be common to all. These four wells represent completion in a total of 1000 feet of section. This is not a typical section for the entire field, since pay section will range from as low as 150 feet to as high as 1000 feet, but actually will average pretty close to 800 feet in the east end of the field. In the case of the four-well group, one well was completed at about 4500 feet as a dual completion, and the other three were single-sand completions ranging up to the most shallow at about 2600 feet.

Since the maximum depth of wells here is about 5000 feet, it is not necessary to have extremely heavy-duty drilling rigs. During the latter part of 1947 six rigs were moved in from Jusepin field and put to work at Quiriquire where they will drill up the newer area and then go back and redrill in the older part of the field to the deeper parts of the formation. The number of drillable locations in the field would perhaps support operations of more rigs, but it is thought that six rigs is just about the most efficient number to operate in the field at the same time as far as supplies of water and fuel are concerned.

Although some sands are found on top of the structure as shallow as 2200 feet, the average drilling depth ranges from about 3600 feet to 4500 feet. Drilling time for completion of wells will average about 20 days for the shallower ones, and up to 35 days for the deeper tests. Drilling conditions are not difficult, but it is all rock-bit operation.

Dehydration of Crude Oil

In producing operations, very little trouble is caused by formation water. There are field knock-outs for some of the fluid, and a number of years ago the operators found it necessary to use two different types of pressure treating systems for dehydration of crude oil. The crude was pumped directly into the trunk line system from the field gathering stations after treatment. However, quite by chance it was found that if the heavy crude from Quiriquire were mixed with the lighter Jusepin crude, the water dropped out in the tanks at Caripito. It was found that as long as the two crudes are mixed the water continues to drop out without treatment; therefore, other systems of special treatment have been suspended. It has been found that on occasions when it is necessary to pump the heavy crude directly to storage tanks, the water fails to settle out.

The plant being placed in operation in the field to handle gas will be strictly for injection into the formations and will do no processing. The gas is quite dry, with about 28 percent carbon dioxide, and very little product could be recovered with an absorption process. A battery of six compressors is to be used, two with 28-inch cylinders to raise pressure from zero to 50 pounds, two with 14-inch cylinders for compression from 50 to 250 pounds, and two with 7-inch cylinders to raise it to 1000 pounds. It is believed that in the injection of about 12 million cubic feet daily the pressure of 1000 pounds per square inch will be needed, although experiment has shown that most wells will take the gas at around 800 pounds. All compressors are driven by 600-horsepower electric motors for which the power will come from either the Caripito or Jusepin stations. An old plant had been built in the field a number of years ago, but it has not been in operation since 1933, at which time it was injecting about 6 million cubic feet of gas daily into the formation.

Creole's office building at Quiriquire.

Ethiopian Inactivity Blamed on British

BRITISH policy, both military and diplomatic, is blamed for Sinclair Petroleum Company's suspension of its oil exploration program in Ethiopia. The company, a subsidiary of Sinclair Oil Corporation, had planned a first test in Ethiopia in the Ogaden area, 350 miles from Diradawa, the concern's main field headquarters. Drilling equipment and other material were on the way when Sinclair was forced to suspend operations because of local political disturbances.

A recent American observer in Ethiopia, Arthur Veysey, writing in the *Chicago Tribune*, calls British policy which has resulted in a shutdown of Sinclair's work "a major scandal," and states there is no true cooperation between American and British officials in Africa. He quotes an unidentified expert in Ethiopian oil affairs as saying that "with one hand the British are seeking billions in Washington and with the other are trying to knock down America in Ethiopia."

The present Ethiopia squabble involves high policy as well as local issues. U. S. interests, Britain and the Somali tribes are all involved, and Veysey reports that the Ethiopians are considering denouncing the postwar treaty with Britain. Sinclair ceased operations when the Somali began attacks and threatened the use of armed force over boundary disputes. Veysey hints that the British actually are instigating the Somali violence, and Sinclair admits it has been able to obtain no protection from the British in order to carry on further development.

Protection Promised

R. J. Bender, a Sinclair representative in Addis Ababa, together with the American Minister, George Merrell, has presented to Emperor Haile Selassie a memorandum reminding Ethiopia that by the 1945 agreement, the Ethiopian government promises protection to oil exploration crews, if such protection is needed, and Britain must accede to such commitment since the Ogaden territory taken by British troops during the war now belongs to Ethiopia. However, British troops still occupy the territory.

Britain in 1942 aided in the expulsion of the Italians from Ethiopia and the restoration of Haile Selassie as emperor, and in 1944 Britain demanded that Ethiopia cede a strip of land in Northern Ethiopia near Eritrea as well as the Ogaden province. Ethiopia protested and for a year the dispute dragged on with increasing British pressure. Then in 1945 Ethiopia signed the Sinclair agreement giving the American oil company 50-year exclusive rights over the entire country in the search for and development of oil resources. Some British officials say they knew nothing of this agreement until the Sinclair equipment began arriving.

Surveyors Threatened

Actually, Sinclair geologists made aerial and ground surveys throughout most of 1947, traveling all through the Ogaden. The first well site was chosen near the village of Warderi, seven miles from a British military post and the company began drilling a water well. Soon the American drilling crews were threatened by nearby Somalis, and company surveyors received threats, too.

Last September Ethiopia proposed to Britain the return of the Ogaden, and London is still studying the request. Veysey reported that in December, 1947, Somali chiefs gathered at Warderi and told the American oil men in the presence of the British that the American operators were unwelcome. The British said they could do nothing about the matter.

On January 5, 1948, the Somali stoned and disabled a Sinclair plane at Warderi, then stoned a Douglas transport owned by the Ethiopian government. The British refused to make arrests after this demonstration, and told an American oil crew numbering 30 men that the British could not be responsible for any attacks if the Americans left their camp to continue drilling work.

On January 14 the Sinclair management ordered its crew to return to Diredawa with all its equipment.

Veysey reports that Britain's policy is probably determined by the fact that the British themselves want the oil rights now enjoyed by the Americans. Meanwhile, Sinclair has no intention of resuming operations until some protection is assured its personnel.

Geophysical Work Continuing In Great Artesian Basin Area

Geophysical work as well as geological investigation is continuing in the Great Artesian Basin area in Australia in an effort to make an evaluation of its petroleum possibilities some time within the next year.

During last year the Vacuum Oil Company, Ltd., and D'Arcy Exploration Party, Ltd., formed the Frome-Broken Hill Company Proprietary Ltd., transferring the exploration licenses to the one company for more facility in operation, and a considerable amount of money and energy is going into the survey.

The Great Artesian Basin extends into the three states of Queensland, New South Wales, and South Australia, the area being investigated covering some 92,100 square miles (58,944,000 acres). The larger part of the area, 35,936,000 acres, lies in South Australia. During last year the interested companies spent something like a third of a million dollars in the area, most of the work consisting of geological reconnaissance and a gravitymeter and magnetometer traverse, following a triangular course between the towns of Patchaworra, Moolawatana and Tiboobarra, with some detail work in the area east of Lake Frome in which the Commonwealth government assisted by providing a geophysical survey party and equipment from the Bureau of Mineral Resources.

In Queensland geophysical work is being carried out in the Roma district by a pool of the four companies holding licenses in the area. A geophysical crew was made available here also by the Commonwealth Government. Shell (Queensland) Development Party, Ltd., is carrying out geophysical work in the Rolleston area, north of Roma, and will continue its investigation in this area by a series of core tests.

Condamine Oil Party, Ltd., which was recently formed and which holds a prospecting permit on 100 square miles in the Chinchilla area, is scheduled to drill wildcats in an area 15 or 20 miles east of the town of Chinchilla, about midway between Roma and Brisbane.

Meanwhile Murilla Oil Ltd. is drilling a wildcat in the Boyanda area, which is below 5914 feet.

In the Australian Northern Territory the aerial and geological reconnaissance work on the part of Australian Mining and Smelting Company, Ltd., has indicated as a preliminary conclusion that the most promising part of the northern basin tested would be off-shore areas in the Joseph Bonaparte Gulf. No actual drilling operations have been reported planned, pending more preliminary work.

Agreement May Be Reached On Austrian Oil Reserves

After prolonged negotiations there is now hope of agreement being reached between the occupying powers on the question of Austrian oil resources. The probable terms are as follows:

(1.) The Soviet Union will receive an allocation of properties with a productive capacity of 58 to 60 percent of the present oil production (against a Soviet demand of two-thirds).

(2.) The Soviet Union will hold the rights to this production for 30 years and will hold the exploration rights for eastern Austria for eight years, plus 25 years for the exploitation of any oil discovered (against a Soviet demand for 50-year contracts in each case).

(3.) Refineries with an existing capacity of approximately 2,900,000 barrels a year will pass into Soviet possession (against a Soviet demand for 3,150,000 barrels capacity).

According to an estimate by the British Minister of State, some 2,700,000 barrels of indigenous oil products were made available by the Soviet Administration for Austrian use during 1947, equivalent to about 40 percent of actual production. Austria had to import an additional 125,000 barrels of products last year in order to meet internal needs.

Nationalists in Iran Seeking To Reclaim Bahrein Islands

Nationalist elements in Iran have recently been working up sentiment for new claims of the Iranians for sovereignty over the islands of Bahrein in the Persian Gulf. Last month the Iranian Majlis, or Congressional body, voted to place at the head of its agenda a bill reasserting sovereignty over the islands, which are under British protectorate as an independent Sheikhdom. The question has been a recurrent one since Persia held the islands from 1622 until 1783. The British have had a special treaty relation with the Sheikhdom since 1820.

Iranians protested when concessions on Bahrein were granted to American interests, carrying on a dispute which has persisted for more than a hundred years. Recently the Iranian authorities announced that telegrams and letters for Bahrein would be dispatched at domestic rates since the islands are considered part of the national territory.

Diplomatic sources in Teheran have indicated a feeling that such an issue is not particularly judicious at this time, especially inasmuch as it is not clear just what steps might be taken to implement any action the Majlis may take. The bill now before the group simply directs the Iranian Government to take steps to set up administrative organization in Bahrein.

Bahrein Island, lying close off the shore of Saudi Arabia, is under concession to the Bahrein Petroleum Company, a jointly-owned affiliate of Standard Oil Company of California and The Texas Corporation, and is the site of an oil field producing 28,000 barrels of crude daily and a refinery with throughput capacity in excess of 150,000 barrels daily.

Well Completed in Spain; More Wildcats Probable

Further wildcat tests are planned shortly in Spain following virtual completion of the first well drilled on the Oliana structure of Lerida in the northeast part of the country, about 60 miles northwest of Barcelona. This first test was drilled to the Tertiary at about 8000 feet. Location is on the Oliana anticline, of Eocene surface formation, about ten miles long by three miles wide. The well was spudded July 1, 1947.

It is believed possible that the second wildcat may be drilled in the province of Burgos in North Central Spain where further exploration has lately been carried out.

Exploratory drilling in Spain is carried on by Cia de Investigaciones y Exploraciones, S. A. (Ciepsa) which is 50 percent owned by Socony-Vacuum Oil Company and 50 percent by Spanish nationals in Cia Espanola de Petroleos (Cepsa). It is reported that the Spanish government may also drill on its own account in the Burgos area.

Considerable interest has been aroused in Spain over the tests because of the country's complete dependence on petroleum products, imports now amounting to about 3 million barrels a year. Shortage of gasoline in Spain has led to restrictions on its use and growing import difficulties have been encountered. Spain is also interested in the oil-producing possibilities of her northern provinces in view of the French government's activities across the Pyranees in the St. Marcet field.

Discovery Completed South Of Sudr Field in Egypt

Anglo-Egyptian Oilfields, Ltd., (Shell) and Socony Vacuum Oil Company have completed a wildcat, Asl 1, about ten miles southerly from the recent Sudr discovery on Sinai Peninsula, eastern Egypt.

It was completed at 3872 feet and flowed at the rate of 600 barrels daily, although the first production tests have been of short duration. Drilling has begun on the second well, about three miles south of the discovery.

Goal of 4,950,000 Barrels Set for Hungary in 1949-50

Under the Hungarian Three-Year Plan a goal of 4,950,000 barrels production has been set for 1949-1950. This might prove difficult of attainment if the producing fields are kept within what might be termed safe efficient producing limits. During the year just completed, the country produced a total of 4,330,430 barrels of crude, a substantial decrease from the 5,145,342 barrels produced during 1946. The principal producer, Lovaszi Field, declined from 3,029,931 barrels in 1946 to 2,625,151 barrels in 1947 despite the completion of 11 producing wells during the year. Discovered in 1940, the field now has 89 producing wells, most of which are flowing, but which must be kept at fairly low rates to conserve reservoir energy. Budafapuszta Field contributed 1,235,554 barrels of the 1947 Hungarian production, showing a decline of more than 320,000 barrels during the year.

The only new discovery of the year was the Hahot-Ederics gas field, opened two miles west of the Hahot oil field. This area has shown promise of being an important gas field on the strength of development to date. During the year five new gas wells have been drilled in the area, and three old dry holes formerly drilled have been worked over into gas wells, all producing from Lower Pliocene sand. Total initial production of the nine wells now in the new field is around 27,000,000 cubic feet daily, flowing through 3/8-inch chokes. No outlet has been provided for the gas and wells are being shut in. With gas coming from sands between 4592 feet and 4920 feet in depth, the area is scheduled for deeper drilling in search of oil production.

The Soviet Hungarian Oil Company has been drilling in eastern and southeastern Hungary on the Korosszegapati structure, where three wells have been completed during the past year, making only wet gas with more than 50 percent CO_2.

23 Million Barrels in 1948 Is Royal Dutch Goal in Sumatra

The Royal Dutch Petroleum Company has set a crude oil production target for 1948 of 23 million barrels of oil from Sumatra, or more than double the 11 million barrels produced during 1938, the last full pre-war year.

Total output from Sumatra during 1947 was 3,857,000 barrels, with many of the former producing areas not yet back on production. The Soerabaja fields produced 326,000 barrels during last year, while Borneo, including both British and Netherlands Borneo, produced 17,046,000 barrels of oil during the year.

Dr. Tolpin Says Russia Progressing Slowly in Synthetic Oil Development

Russia has made little progress in development of synthetic oil despite her urgent need for gasoline and other petroleum products, said Dr. J. G. Tolpin, speaking before the American Chemical Society in Chicago April 20.

Dr. Tolpin, of Standard Oil Company of Indiana, speaking on "Highlights of Present-Day Russian Chemical Research," emphasized that he was not attempting to evaluate the significance of any phase of Russian research but was merely reviewing published Soviet material.

He said that Soviet chemists, trained to regard petroleum as a valuable chemical storehouse, have intensified some lines of research on chemicals from crude oil, but large-scale plant work on their manufacture is not reported in Russian literature, although it is widely discussed. Exceptions are naphthenic acids used in making rubber, plastics and fungicides and some other established products.

Butadiene, basic raw material of widely used synthetic rubbers, was first made in Russia in 1926 in the development of its synthetic rubber industry, and intensive research has been going on since.

Tolpin said that by 1950 petroleum production is expected to reach 241,500,000 barrels a year, and that gas will be produced from shales in Estonia, Gdov, and the Volga. He said gas from peat was used commercially before the war and that wood chips and stump turpentine were burned in internal combustion engines on a limited scale during the war.

Tests of other petroleum substitutes such as coal, peat and shale tar fractions and synthesis from water gas are in the laboratory or pilot plant stage, according to Tolpin, and coking of shale on a plant scale may be started soon. The plans visualize a yearly production of 44,300,000 tons of peat and around 8 million barrels of liquid fuel from coal and shale by 1950. He also said there are indications of large scale use of oxygen in underground gasification of coal, steel, metallurgy, and numerous other processes.

"The chemical researches in progress in the USSR are influenced by the Russian needs of the moment as well as by large scale projects of long duration where the traditions of the Russian school of chemistry and the habits of maturing personnel play an important part," Dr. Tolpin asserted.

Australian Asphalt Plant Slated for Full Operation

Bitumen and Oil Refineries (Australia) Ltd.'s new asphalt plant in Sydney, Australia, was scheduled to be in full operation in June. Arrival of the first cargo of crude from Bahrein was to have started partial operations during May.

The asphalt plant, located on a 47-acre site adjacent to Bunnerong Power Station, is convenient to road and rail facilities for distribution of product, and is also convenient to Botany Bay where tankers will discharge crude for use in the refinery. An extensive plant has been constructed to handle packing and shipping of the asphalts. The refinery itself will include distillation equipment, vacuum reduction equipment for reducing the crude charge to desired viscosity, air-blowing equipment for ductility, and viscosity control.

The first asphalt plant in Australia, it will manufacture a complete line of asphaltic products including materials for road paving, roofing, and industrial grades. The nation has heretofore been dependent on imports of asphalts for roads and industry, but will now be in a position to draw upon a local source for about 50,000 tons annually.

Bitumen and Oil Refineries (Australia), Ltd., is capitalized at 1,250,000 Australian pounds (about $4,012,500 U. S.). Forty percent of the stock is owned by the Caltex organization, while the remaining 60 percent is widely distributed among the Australian public.

D'Arcy's Formby 1 Is Now Deepest Well in Britain

D'Arcy Exploration Company has carried its Formby 1, in the County of Lancashire, to a depth of 7680 feet where it is still in the Pendleside Limestone. At this depth, where drilling has been suspended, the well is the deepest to be drilled in Great Britain. Meanwhile, the prospecting license covering 197 square miles in the Formby area, originally granted in 1940, has been extended for another 12 months. The acreage had been taken on the strength of oil seepages in peat near the town of Formby, situated just north of Liverpool on the west coast, and a series of 49 shallow coretests had been drilled as well as four deeper wells.

Results have included 12 producers which have found production as shallow as 80 feet and as deep as 250 feet in sand and shales of Triassic age. Although the wells have been small producers, making a total of only about 7 to 10 barrels daily, the slow rate of decline during seven years production has led to the theory that the producing formation is fed from deeper beds, but thus far deeper drilling has failed to establish production deeper than the original shallow horizon.

Five wildcats drilled in Britain during 1947 have all been dry, but the search for oil continues in an effort to bolster indigenous oil supply. Current production from the five producing areas in Britain now amounts to only 900 barrels daily, comparing with 1047 barrels a day a year ago.

Current geophysical work includes a gravity meter survey in progress in the area south of Lincoln, and a seismic survey in the Lulworth area of Dorset.

Tide Water to Import Crude From Middle East This Summer

Tide Water Associated Oil Company will import Middle East crude into the U. S. this summer. This will be the third American company, together with Standard Oil Company (N. J.) and Socony-Vacuum Oil Company, planning large shipments of crude from the Persian Gulf.

William F. Humphrey, Tide Water president, announced that the first tanker tenders of Middle East crude received will be used for experimental refining purposes at the company's Bayonne, N. J., plant. It is planned to lift the first cargo during June for arrival at Bayonne in July. One-way trips for tankers from the Persian Gulf to the U. S. East Coast takes about 30 days, including loading and discharging time.

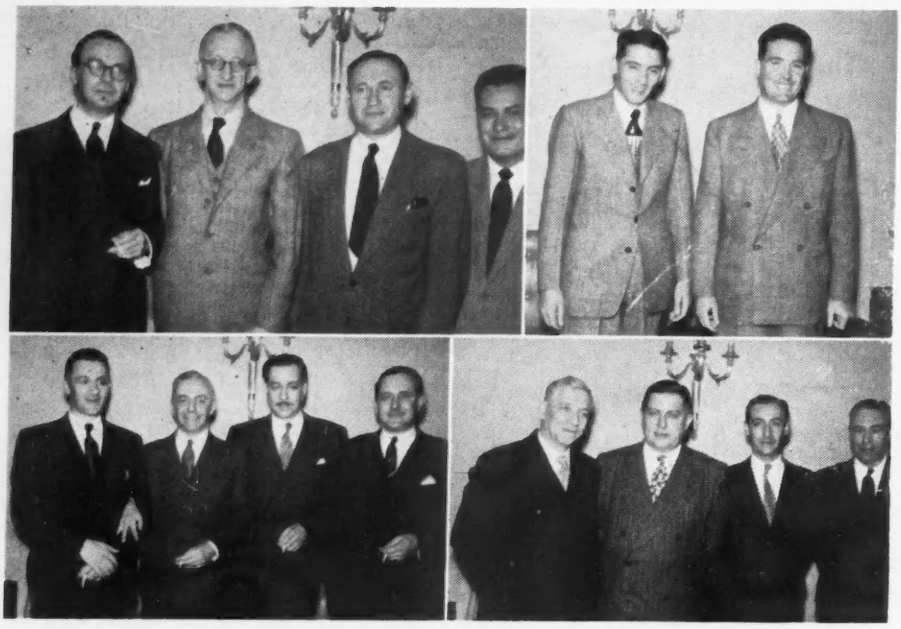
In disclosing the import program, Tide Water said: "The purchase and importation of Middle East crudes are necessary because of the short supply of domestic crudes in the Gulf Coast area and are to supplement the company's supply of domestic crude in order to help meet the increased demands for petroleum products in the Eastern marketing area served by the company."

Tide Water will use its own tankers for the Middle East haul and will decide how many ships to put in service after determining the results of the refinery test runs.

Meanwhile, Socony-Vacuum's millionth barrel of crude from the Middle East has been received at that company's Paulsboro, N. J., refinery. The millionth barrel was part of a cargo of 110,000 barrels unloaded from the tanker "Plattsburg" in Mid-May. Later last month another crude cargo from the Middle East arrived for Socony-Vacuum on its tanker "New London."

These imports, the company explained, "represent part of the company's effort to meet the unprecedented demand for petroleum products in this country."

Socony-Vacuum's imports will average 17,000 barrels daily for the rest of this year.



NOMADS GUESTS—Foreign guests at the April meeting of the New York chapter of Nomads were, top left, left to right, D. G. Hitt, Anglo Iranian Oil Company, London; W. G. Nicholls, Kuwait Oil Company; I. J. Teitelbaum, Argentine Government Oilfields (Y.P.F.); and C. B. O'Connor, Pan American Airways, Brazil. Top right, left to right, L. Walker, Union Tractor & Equipment Company, Canada; S. P. King, Creole Petroleum Corporation, Venezuela. Bottom left, left to right, F. G. Cance, S.N., M.A.R.E.P., Paris; M. J. Galpin, IDECO-Clark, London; E. F. Fabres, Corporacion de Fomento, Chilean government; M. Binet, S.N., M.A.R.E.P., Paris. Bottom right, left to right, J. R. Simpson, Imperial Oil Ltd.; C. A. Rodstrom, Arabian American Oil Company; H. A. Gonzalez, Argentine Government Oilfields (Y.P.F.); and J. A. C. Armstrong, Imperial Oil Ltd.

Oil Production in Venezuela Continues at High Rate

Venezuela continues to produce oil at a rate well ahead of the peak production of 1947. Production of 40,736,424 barrels during the month of March brought the total for the first quarter of the year to 118,058,373 barrels, and output is being maintained at a higher rate than during the first two months.

Creole Petroleum Corporation, the leading producing company in Venezuela, accounted for 21,115,215 barrels of oil during March, a daily average of 681,113 barrels, and indications are that even this figure will be increased as the year progresses.

The monthly total of nearly 41 million barrels for March of this year compares with a monthly average for the entire year of 1947 of 36,229,968 barrels. Currently the Western Venezuela region, including the Lake Maracaibo and the more westerly Cretaceous production, is producing nearly 72 percent of the nation's total output.

With expansion of production in the Cretaceous fields of La Paz, Mara and West Tarra, the Shell group of companies has shown a corresponding increase in total Venezuela output.

200 Attend Houston Reunion Of Former Tampico Workers

Men who formerly worked in the oil fields of Mexico, and their wives, held a Tampico reunion at Ye Old College Inn in Houston, May 5. Nearly 200 attended. James W. Bradbury, formerly manager for Mexican Gulf in Tampico, presided.

By unanimous vote the assembly decided to hold an annual celebration each year on May 5. They also voted to accept the invitation of Tony Mendive to be his guests at a picnic at his home west of Houston in September. To this picnic all former Tampico oil men in the Houston area and the Houston Chapter of Nomads are invited.

Unconfirmed Reports Indicate Two New French Discoveries

Recent reports from France, as yet unconfirmed, indicate possibility of discovery of oil in two new localities. Societe Nationale des Petroles du Languedoc Mediterranean (SNPLM), operating a concession in southern France, on which ten rigs are active, has reported discovery of substantial oil showings in a well near Beziers at a depth near 2400 feet. No detailed information has been received other than that early last month preparations were being made for production tests.

Meanwhile it is reported that oil sands have been discovered at a depth of 1100 feet in a well drilled under the direction of the French Government near Lake Annecy in the Upper Savoy region of the French Alps. It is understood that promising indications of oil have been noted in several areas of the Savoy region and that previous exploratory work has revealed showings near Chatillon, Sur-Cluses, and at Saint Jean de Sixt.

First Modern Gas Pipe Line Completed in Czechoslovakia

Czechoslovakia's first modern long-distance gas pipe line has just been completed, leading from the Stalin synthetic oil plant at Zaluzi to Prague and the industrial districts of northwestern and central Bohemia. The laying of the line has taken two years and the gas to be carried is a byproduct of the synthetic fuel which is being produced from soft coal at the Stalin works.

The nation is now likely to have to re-orient its petroleum industry toward imports from Eastern Europe. Imports of petroleum products in 1947, which totaled some 2½ million barrels in 1947 as against about 2¾ million barrels the previous year, came principally from Russia, Roumania, Austria and Hungary under trade and barter agreements or as reparations. In 1947 import figures are only about two-thirds of the normal pre-war total, and the demand is estimated at more than 3,200,000 barrels annually. The Stalin works at most is believed to produce about 750,000 barrels a year of gasoline and diesel fuel at an extremely uneconomic cost, and some 210,000 barrels of motor fuel a year are obtained from coke ovens and gas works. It has been reported that in order to save coal and also to reduce production costs, fuel oil is being used as raw material in the hydrogenation process.

It is believed that Czechoslovakia's indigenous crude oil output has made hardly any advance since the close of the war due to shortage of equipment and currency for purchase abroad. Current production is only about 245,000 barrels a year as against the 1,400,000 barrels looked forward to under the Two Year Plan. The crude oil reserves lie principally in West Slovakia where the producing field of Gbley has been producing since 1913.

Roumanian Constitution Gives Subsoil Resources to State

The new Roumanian constitution which recently passed into law has established the subsoil resources of the nation as belonging to the State. It is now expected that further measures to implement this constitutional principle will be enacted in the near future.

Miron Constantinescu, Minister for Mines and Oil, has appointed an administrator to direct the affairs of the Distributsia Company which handles the distribution of more than 60 percent of Roumania's total oil output. The Astra Romana and Romano Americana oil companies, owned by British and American interests respectively, which are now supervised by administrators on behalf of the State, are major shareholders in the Distributsia company.

NEW AND IMPROVED Equipment SUPPLEMENTING COMPOSITE CATALOG

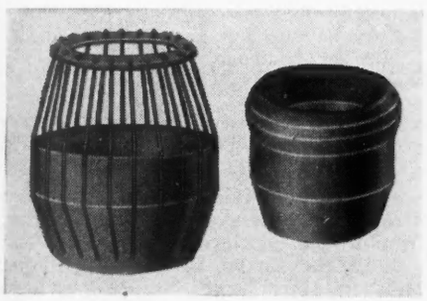
New and improved equipment of manufacturers who describe their products or services in the current Composite Catalog

50—Packer Cup

This item supplements The Guiberson Corporation's data as shown on pages 1497-1548 of Composite Catalog.

The new Guiberson Type "GW" packer cup used with the Guiberson type "K" swab, is now being produced in all standard sizes. The new packer cup is said to be ideally suited for use in swabbing old wells, or when used in wells containing strings of mixed or bad pipe. Due to the tight fit against the tubing or casing wall made possible by the properties of this flexible lip cup, it is especially valuable in swabbing wells with a low fluid level or in taking water off gas wells.

This new cup has been designed for special jobs and does not supplant the



Type "K" Cup **Type "GW" Cup**

standard type "K" packer cup for routine swabbing operations. Both cups are made of the same oil-resistant materials and in sizes to fit all tubing and casing dimensions. Wider versatility is claimed for users of the type "K" swab with the addition of this new "GW" packer cup as an added accessory, since it is readily interchangeable with the type "K" packer cup.

For additional information write The Guiberson Corporation, P. O. Box 1106, Dallas, *referring to* World Oil *item* 50.

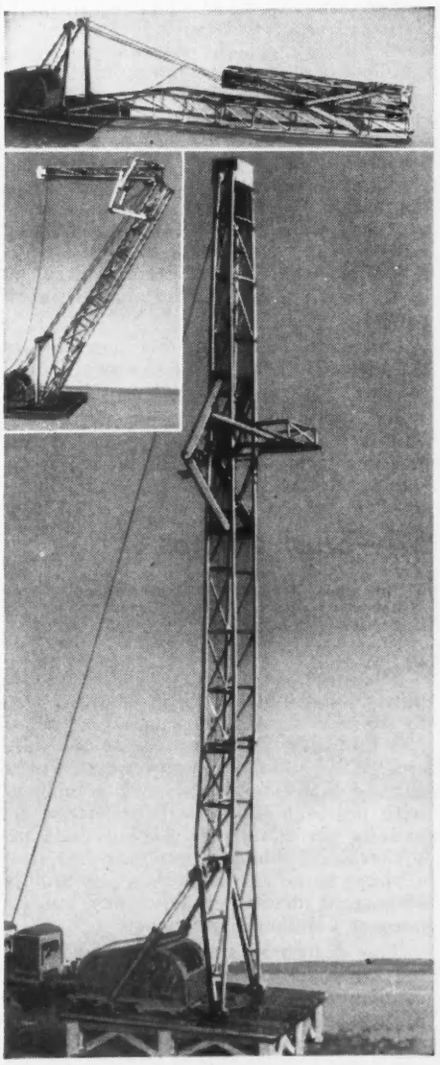
51—Jack-Knife Derrick

This item supplements Franks Manufacturing Corporation's data as shown on pages 1333-1368 of Composite Catalog.

The new double-jointed, 130-foot, thribble, jack-knife derrick with a 16-foot base can be folded into a single load for offset or location-to-location moving, complete with lines and block strung and ready for immediate erection at the new location. For over-highway moving, the Franks derrick folds into two parts, each section making a single truck load. The pipe racking board on the new derrick never has to be removed when moving the derrick, for it folds neatly against the upper section when the derrick is laid down.

This new design eliminates the need for guy lines, and the derrick does not have to be snubbed up with a winch truck or lines. The drawworks performs all the lifting work required. The traveling block, hook and drilling lines, which are strung up at all times, are used to raise and lower the derrick through power furnished by the drawworks.

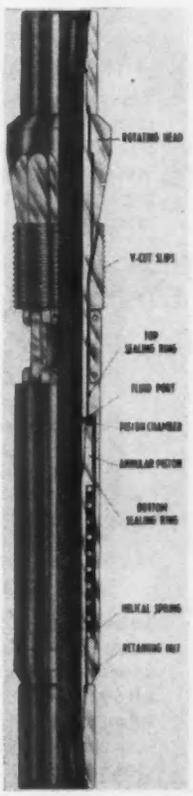
For additional information write Franks Manufacturing Corporation, P. O. Box 3218, Whittier Station, Tulsa 8, *referring to* World Oil *item* 51.



52—Tubing Anchor

This item supplements Page Oil Tools, Inc.'s data as shown on pages 3322-3325 of Composite Catalog.

The new Page "Tension" Tubing Anchor provides a hydrostatically-set, hydraulically-held tubing anchor for anchoring tubing in pre-set tension. Its unique spring-retracted slip design assures full run-in of tubing without danger of pre-setting slips before desired depth is reached. A helical spring in the lower part of the anchor retracts the slips during run-in and pull-out of the tubing.

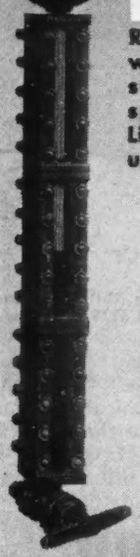


The Page anchor employs helical spring action as a safety feature to retract and hold the slips in their unset position. Before setting the anchor, the tubing string is elongated by slacking the weight of the rods against the pump shoe. After the tubing is elongated the desired amount, it is completely filled with fluid to create a hydrostatic pressure on the anchor. The pressure enters through ports between two sealing rings to cause an upward thrust on the slip piston to engage the slips and a downward thrust on the tubing to pull the cone of the anchor into the slips. The hydrostatic head employed to force the annular piston upward holds the slips in strong tension against the casing wall. By the hydraulic principle, the pressure thus held exerts equal resistance to upward or downward movement of the tubing within the casing regardless of pumping conditions. The Page anchor is released by bleeding the tubing of fluid and allowing the helical spring to retract the slips into their unset position.

For additional information write Page Oil Tools, Inc., P. O. Box 7126, Bixby Knolls Station, Long Beach 7, Calif., *referring to* World Oil *item* 52.

■ CONTINUED ON PAGE 250

PENBERTHY
Liquid Level GAGES

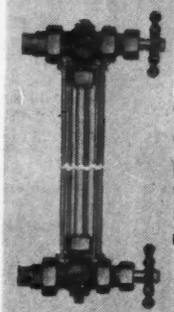


REFLEX

Reflex type complete with gage valves. Liquid shows black—empty space shows white. Liquid level is always unmistakable.

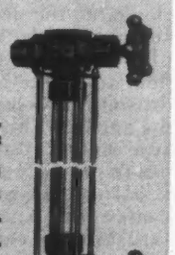
TRANSPARENT

Transparent type complete with gage valves. Used where through vision is desired under high pressures and/or temperatures.



DROP FORGED STEEL

Tubular glass type, Chrome-Moly temperature resisting steel body, stainless steel trim, regrinding removable seats.



ALL IRON

Tubular glass type, extra heavy body of special high strength alloy iron, shanks alloy steel, trim stainless steel, valves self-cleaning.

There is a Penberthy Gage of superior quality for every liquid level gage requirement. Gages are fabricated to customer's specifications from special alloys to meet unusual corrosive and temperature conditions. All Penberthy Gages conform with API-ASME requirements.

3277-B

PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant — Windsor, Ontario

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

53—Connectors

This item supplements Web Wilson Tools, Inc.'s data as shown on pages 4317-4340 of Composite Catalog.

Connectors have been designed to eliminate all load-carrying threads. In place of the threads, a shear ring has been incorporated on the main shank. The heat-treated, alloy steel shear ring gives extreme strength and simplifies assembly and disassembly in the event that repairs are required. These connectors are designed for their rated capacity with a safety factor of four-to-one on the ultimate strength of the steel. Connector length has been kept to a minimum to permit maximum working room in the derrick. They have been designed for direct connection to the bottom of most makes of traveling blocks.

A simple, positive locking device, consisting of only three parts, locks the connector in any of eight different positions. The lock may be operated from the derrick floor by a hook rod furnished with each connector. The plunger and bearing operate in a full oil bath. This oil cushion assures lubrication of the bearing and provides a controlled, hydraulic cushioning action for the spring. This feature prevents the drill pipe from bouncing when breaking out. The main bearings are adequately sealed against intrusion of foreign material or leakage of lubricant.

Large link recesses on either side of the body will accommodate any standard drilling or production link in use today.

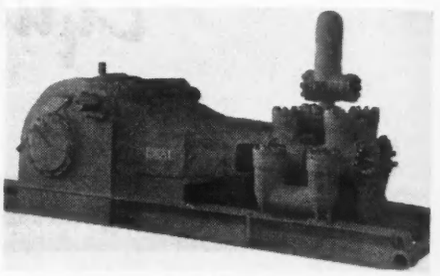
For additional information write Web Wilson Oil Tools, Inc., W. W. Wilson Building, Huntington Park, Calif., *referring to* WORLD OIL *item* 53.

54—Slush Pumps

This item supplements The National Supply Company's data as shown on pages 2793-2892 of Composite Catalog.

The new ideal type E-700 duplex power slush pump has an 8½-inch bore by 16-inch stroke and a rated output of 700 hydraulic horsepower. It will discharge 955 gallons per minute at a pressure of 1260 pounds per square inch, or, with 6¼-inch liners, will discharge 485 gallons per minute at 2480 pounds per square inch. These figures are based on a pump speed of 65 strokes per minute, 85 percent mechanical efficiency, and 100 percent volumetric efficiency.

The design is similar to that of the four lower capacity C-series, but with refinements that give greater power per unit weight. These include the use of cast steel instead of cast iron, welded



frame construction, and an aluminum main frame cover.

The pump frame is constructed of steel plate and steel casting electrically welded into one unit and stress relieved. The fluid end is a one-piece steel casting with no internal baffles or walls, and with cylindrical sections for maximum strength. The air chamber has a capacity of 2150 cubic inches to smooth out the discharge. To reduce shock resulting from load reversals, the main bearings and connecting rod bearings are preloaded. The crankshaft is a one-piece alloy steel casting. Special high-strength and wear-resistant materials are used wherever necessary. An exclusive feature of the lubricating system is a means of preventing contamination of the crankcase oil by the drilling fluid.

For additional information write The National Supply Company, Box 899, Toledo 1, Ohio, *referring to* WORLD OIL *item* 54.

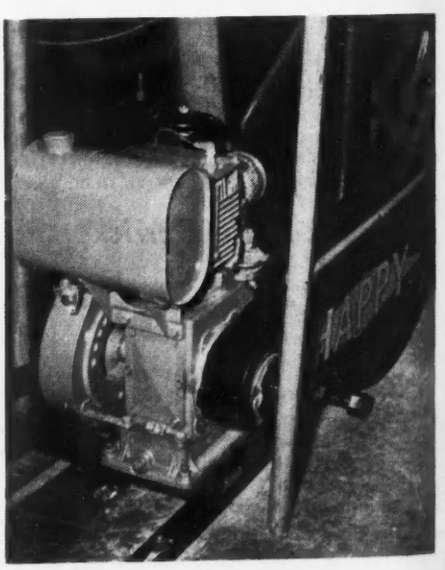
55—Engine Starters

This item supplements The Happy Company's data as shown on pages 1692-1693 of Composite Catalog.

The new P & H engine starters consist of an air-cooled engine, a V-belt drive, friction pulley, lever, base, and belt guard. They have been designed and built to start large engines equipped with exposed flywheels.

There are four models for engine sizes from 15 through 80 horsepower. Special units can be designed for engines over 80 horsepower. The friction pulley rests

■ CONTINUED ON PAGE 251



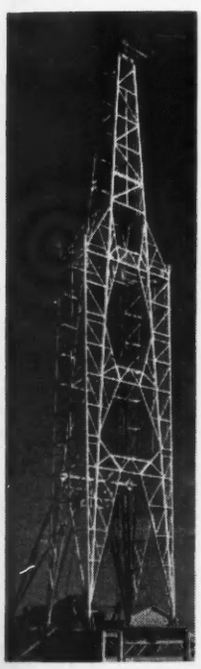
on the face of the engine flywheel, causing the latter to rotate. Base of the starter is slotted so that it can be adjusted to the proper friction necessary to rotate the heavy flywheel. The small engine on the starter is first placed into operation and the friction pulley forced to bear against the flywheel, causing it to turn. Once the large engine is operating, the friction pulley is disengaged from the flywheel and the starter engine stopped.

For additional information write The Happy Company, Drawer 770, Tulsa, *referring to* WORLD OIL *item* 55.

56—Portable Mast

This item supplements Emsco Derrick & Equipment Company's data as shown on pages 1201-1228 of Composite Catalog.

A new bulge-type portable mast for deep drilling designated as the 18P Mast may be equipped with either one or two bulges. The double bulge construction is especially advantageous when the mast is barge-mounted for workover operations on water locations. It permits the simultaneous racking of both drill pipe and tubing.



The 136-foot height and the crown block capacity of 800,000 pounds make the 18P portable mast comparable to standard API derricks that have been used for drilling to depths in excess of 15,000 feet. The Emsco bulge-type portable mast permits adequate supporting of all four legs by exterior bracing. This design allows the mast to be rated by the same conservative standards established by the API for standard derricks. The 18P portable mast is designed to withstand winds of 70-mile-per-hour velocity with a full setback of pipe standing in the bulge. No guying is necessary.

Another outstanding feature of the Emsco 18P portable mast is the amount of racking space available. The base dimensions of 16 by 26 feet are sufficient to accommodate the largest drawworks. The 26-foot base dimension extends up vertically to the working platform. One hundred and ninety-two stands of 4½-inch drill pipe may be racked in a single bulge while holding the inside stands five feet from the center of the well.

For additional information write Emsco Derrick & Equipment Company, P. O. Box 2098, Terminal Annex, Los Angeles 54, *referring to* WORLD OIL *item* 56.

57—Welding Contactor

This item supplements Black, Sivalls & Bryson, Inc.'s data as shown on pages 633-652 of Composite Catalog.

A rotating welding contactor which has been in use in the plants of Black, Sivalls & Bryson, Inc., for several years will be manufactured for the welding industry.

The copper rotating contactor and bronze stationary contactor are held together by a spring loaded ball-thrust bearing. A cast aluminum bonnet is bolted to the stationary contactor and seals the unit, excluding dirt and foreign material. The bonnet is provided with a grease fitting so that the unit may be lubricated. Any electrical contactor grease may be used.

The rotating contactor is provided with a ⅞-inch threaded bronze stem to which the welding work is fastened. The ground cable is bolted to the stationary contactor by a ⅝-inch steel stud.

■ CONTINUED ON PAGE 252

It's amazing what one man can do with a winch-equipped truck and the HOBBS Self-Loading Float. Here is the team that can load and unload heavy loads of as much as 30 tons.

Engineered so the front end is lowered by winch to an easy-grade ramp position (top photo), the Hobbs Self-Loading Float makes use of the winch for drawing the load on and off. Photo below shows the Hobbs Self-Loading Float being elevated into hauling position after load is in place and truck has been returned to front.

Illustrated Literature FREE ON REQUEST

HOBBS MFG. CO.
FORT WORTH — SAN ANTONIO
HOUSTON—DALLAS—LUBBOCK

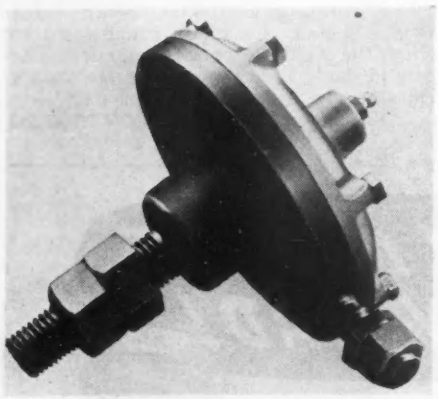
Dept. W

Clip and mail Coupon

HOBBS MANUFACTURING CO.
609 North Main Street, Fort Worth 6, Texas
Please send (without obligation) details about the HOBBS Self-Loading Float.

NAME _____
ADDRESS _____
CITY _____ STATE _____

Specific advantages claimed for the Rotating Welding Contactor are: (1) it prevents the ground cables from snarling and twisting; (2) it doesn't overheat; (3) its minimum of moving parts gives easy, trouble-free operation: (4) owing to the high load capacity of the



rotating contactor, it is well suited for use with automatic welding machines using high currents. Its rating is better than 4-0 cable.

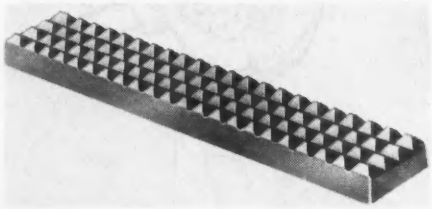
For additional information, write Black, Sivalls & Bryson, Inc., 720 Delaware, Kansas City 6, Mo., *referring to* WORLD OIL *item* 57.

58—Tong Dies

This item supplements Web Wilson Tools, Inc.'s data as shown on pages 4317-4340 of Composite Catalog.

A new type of tong die is available under the trade name of "Tiger Tooth." Tiger Tooth Tong Dies have a pyramidal pointed tooth pattern that assures a positive, "biting" grip on the hardest tool joints under the strongest pulls. They are especially recommended for flame hardened and hard metal surfaced tool joints or wear subs.

The sloping sides and heavy base of the pyramidal shaped teeth give extra strength and backing to each tooth and prevent the Tiger Tooth Tong Dies from easily breaking down in severe service. They are of the "full length" design that completely fills the die slot in the tong and are reversible to provide extra service life. They will fit all tongs used in the oil fields today.

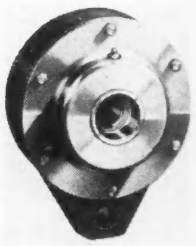


For additional information, write Web Wilson Oil Tools, Inc., Huntington Park, Calif., *referring to* WORLD OIL *item* 58.

59—Falk Backstop

This item supplements The Falk Corporation's data as shown on pages 1278-1279 of Composite Catalog.

The new Falk backstop is said to provide a positive method for preventing reverse rotation on conveyor drives, elevator head shafts, windlasses, winches and on all applications where reverse rotation should not occur.

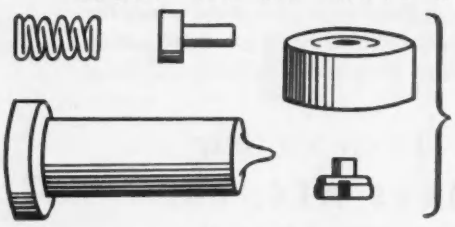


"Back-run" or reverse rotation, in some machinery operations, may cause serious damage to the machinery and the material being handled. The gripping action of the Falk Backstop takes place at the precise moment that forward rotation ceases. It reduces the possibility of shock or strain to a minimum.

For additional information, write The Falk Corporation, 3001 West Canal St., Milwaukee, Wis., *referring to* WORLD OIL *item* 59.

■ CONTINUED ON PAGE 254

Below Your Costs
Best Buy Today
Government Surplus—Now
"71"
DIESEL GM PARTS
Complete Assembly or Individual Parts
SPRAY TIP and VALVE ASSEMBLY



No. 5227325
Spray Tip and Valve Assembly consists of
1 Stop Check
1 Valve Spring
1 Spray Tip—7 hole
1 Valve and Seat
Sold in part or as complete assembly

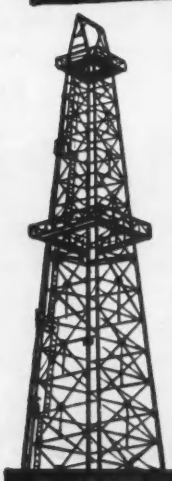
These and many more

NUMBER	DESCRIPTION
5226888	Injector Filter Element
8502957	Oil Cooler Element 12 Stack
5227325	Spray Tip and Valve Assembly
5227231	No. 80 Injector and Case
5157393	Blower Assembly—Left
5157396	Blower Assembly—Right

Write for complete parts list and low net prices.

SURPLUS AUTOMOTIVE COMPANY
"DEISEL PARTS SPECIALISTS"
1329 S. MICHIGAN AVE. CHICAGO 5, ILLINOIS

THOMPSON-HAYWARD FORMALDEHYDE
Reduces
CORROSION



- Save on Pulling Costs
- Save on New Steel
- Save on Shutdown Time
- Low Cost
- Dependable
- Field Tested

Protect expensive and hard-to-get steel parts from hydrogen sulphide corrosion and corrosive mine and well waters, with Thompson-Hayward Formaldehyde.

Warehouse Stocks Available
For Prompt Shipment

THOMPSON-HAYWARD CHEMICAL CO.
DALLAS WICHITA HOUSTON TULSA NEW ORLEANS DENVER SAN ANTONIO

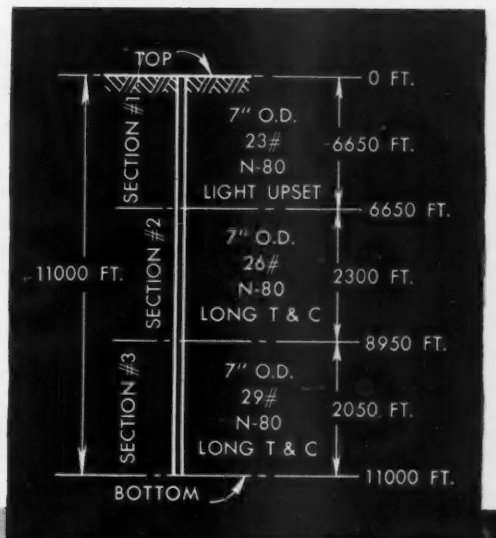
You can save... by using COMBINATION casing strings

THE term "combination casing" is generally applied to a casing string composed of more than one weight per foot, or more than one grade of steel, or of both.

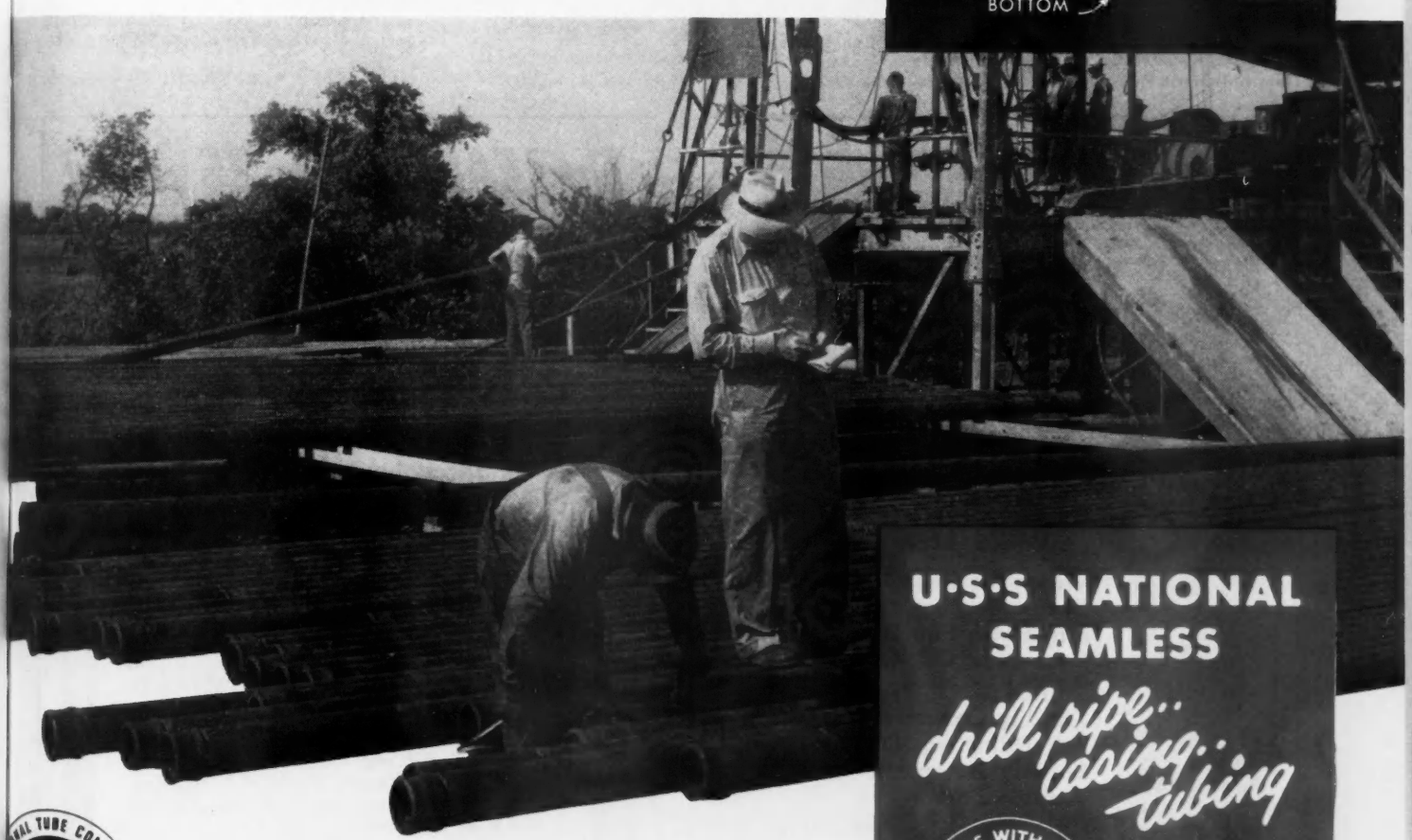
Under certain conditions, substantial savings can be effected by a suitable combination of weights and grades of casing, particularly when used in deeper wells.

For example take the 11,000 foot well shown in the accompanying chart. With a combination string as shown the weight totals 272,200 pounds. If the heaviest casing had been used all the way down, the weight would have been 319,000 pounds, or 46,800 pounds more.

National Tube Company has prepared a booklet entitled, "Combination Casing Strings" which gives complete calculations for wells from 3,500 to 16,100 feet deep and for casing 5½" to 7" O.D. This booklet which supplements National's Bulletin No. 15, Seamless Drill Pipe, Casing, and Tubing will give you valuable help in planning your casing strings. Write for a copy if you do not have one — National Tube Company, Frick Building, Pittsburgh, Pennsylvania.



A typical design for an 11,000-foot casing combination string which weighs 46,800 pounds less than the conventional string. For details of design see National Tube Company Bulletin No. 15.



U·S·S NATIONAL SEAMLESS

drill pipe... casing... tubing

WALLS WITHOUT WELDS

NATIONAL TUBE COMPANY

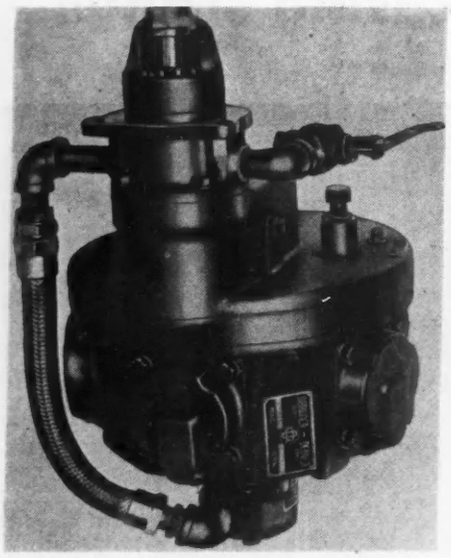
PITTSBURGH, PA.

United States Steel Export Company, New York

UNITED STATES STEEL

60—Air Starter

This item supplements Gardner-Denver Company's data as shown on pages 1372-1379 of Composite Catalog.



A new line of air starters for gas, gasoline or diesel engines—including five sizes, developing from 3 to 15 horsepower on 100 pounds air pressure—has just been designed by Gardner-Denver Company.

The principal advantages claimed for these air starters are their extremely high torque and the elimination of costly battery maintenance and replacements. The high torque characteristics of the piston type motor makes it especially desirable for Diesel applications involving high starting loads, while the five-cylinder radial design provides even torque through the operating cycle.

An exclusive feature is an air-actuated starter pinion which, when the air valve is open, automatically engages the ring gear a split second before the starter begins to crank the engine, thus assuring positive and safe engagement.

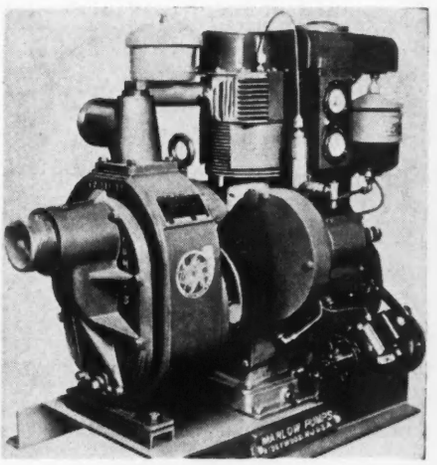
For additional information, write Gardner Denver Company, Quincy, Ill., *referring to* WORLD OIL *item* 60.

61—Small Pumping Unit

This item supplements R. H. Sheppard Company, Inc.'s data as shown on page 3509 of Composite Catalog.

The 220 G.P.M. self-priming centrifugal pump is especially suited for use where the storage and handling of gasoline is hazardous, where continuous operations make fuel economy important, or in foreign countries where cost of gasoline is prohibitive.

The unit is powered by the smallest diesel engine available. It is a single cylinder Aircooled Sheppard, rated at 3½ continuous horsepower at 1800 revolutions per minute. Being of full diesel design, its operation is extremely economical as one gallon of domestic fuel oil will pump 36,500 gallons of water.



The unit is equipped with electric starting and full pressure lubrication is used.

For additional information, write R. H. Sheppard Company, Inc., 73 Middle Street, Hanover, Penn., *referring to* WORLD OIL *item* 61.

■ CONTINUED ON PAGE 256

BOWEN
AUTOMATIC LINE WIPER No. 8000

Bore of Body	2¾"
Connection	3"
For Line sizes	3/16 to ⅞"

for

SWABBING - BAILING
WIRE LINE CORING

*Wipes the line clean
*Keeps the floor clean
*Eliminates Fire Hazard
*Conserves Oil, Gas, or Drilling Fluid
Sturdily Constructed
Self Adjusting
Entirely Automatic
Trouble Free

Other models including Casing Sizes and Special Purpose Types are available and in stock.

Complete details will be mailed on request

THROUGH YOUR SUPPLY STORE ANYWHERE

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Office: 2429 Crockett St., P. O. Box 1025, HOUSTON 1, TEXAS, Phone C-9457
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The LEADER...for 25 years!

MILLER SAND PUMPS

And Regular Bailers

- **Thousands of MILLERS in use Throughout the World!**
- **The Standard Clean-out Tool!**

O. D. Sizes on MILLER SAND PUMPS are: 2½, 3, 3½, 4¼, 5, 5½ and 7 inches. Lengths are 20, 25 and 30 feet. The bail is welded to heavy seamless steel tube. Long heavy grooved plunger assures a liquid seal. Has three interchangeable bottoms. Wire line is direct connected to plunger—gives greater suction. DOES THE JOB! FAST! ECONOMICAL!

MILLER REGULAR BAILERS are made in 2½, 3, 3½, 4¼, 5, 5½ and 7 inch O.D. sizes and in 20, 25 or 30 foot lengths. Sectional Bailers made to your specifications. See Composite Catalog, page 2666, for prices, parts and details.

MILLER SAND PUMP CO.

1524 SE 29th Street
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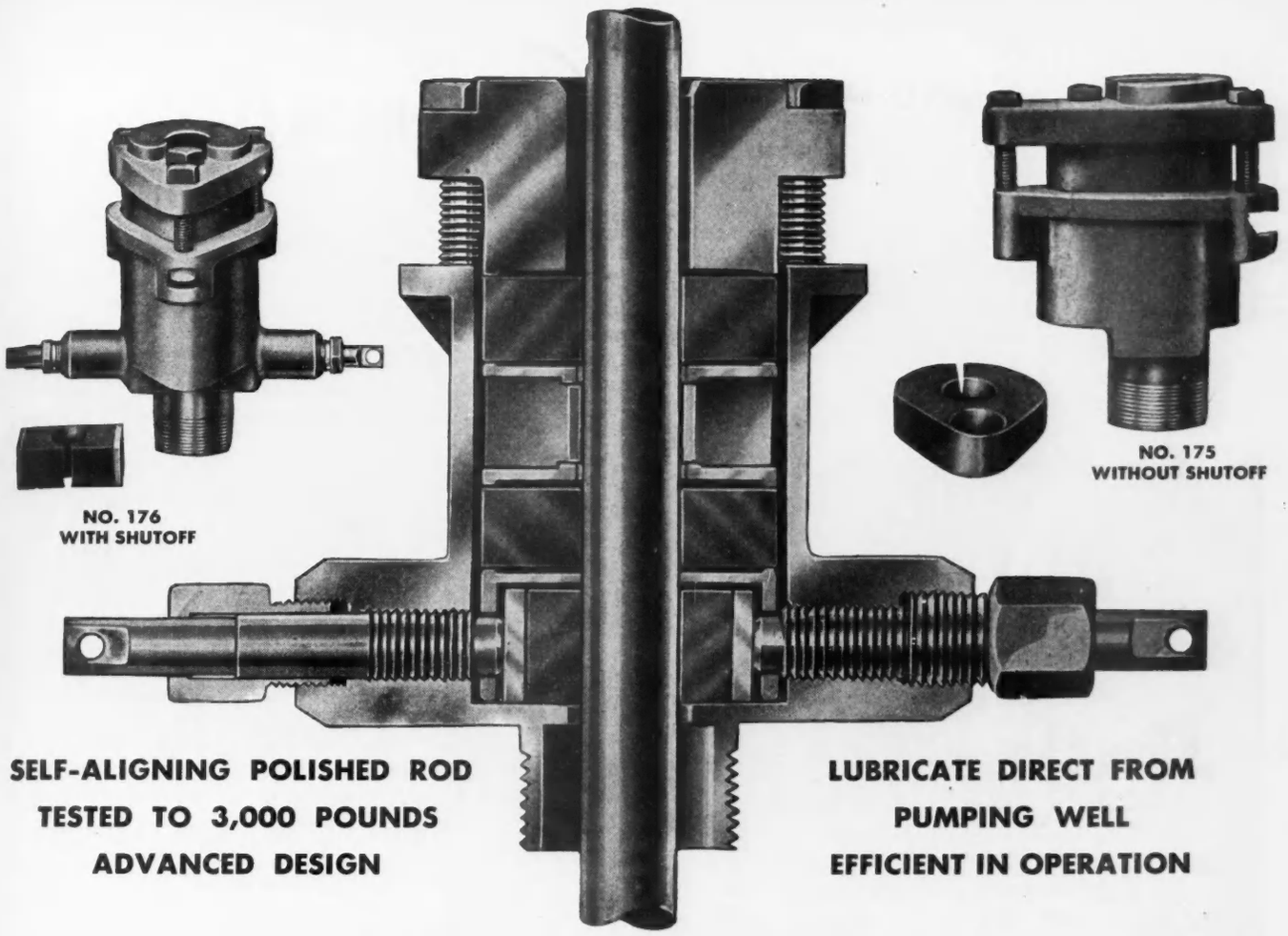
Export Office
30 Rockefeller Plaza, New York 20, N. Y.



SELF-ALIGNING POLISHED ROD
TESTED TO 3,000 POUNDS
ADVANCED DESIGN

LUBRICATE DIRECT FROM
PUMPING WELL
EFFICIENT IN OPERATION

RATIGAN *Self-Oiling* STUFFING BOXES

Ratigan Stuffing Boxes are the only self-oiling stuffing boxes on the market. They are excellent examples of modern design and sound engineering, and receive their lubrication directly from the pumping well.

Ratigan No. 175 and No. 176 Stuffing Boxes are identical except that the No. 175 has no shut-off feature. They are made of high grade electric steel and tested to 3,000 pounds pressure. The inside of the box is removable, so that the device has two oil chambers. Another arrangement inside the body keeps these two chambers filled with fluid from the well, providing positive self-lubrication without depending on the human element.

The No. 176 can be shut off while repacking the box, by tightening the screws evenly in the shutoff; but caution must be exercised, as the screws will have to be loosened before the well starts to pump. If not, the fluid will not get up into the stuffing box.

The hole in the rubber is made for the size of the polished rod; while the hole in the metal parts of the body are larger; a design that makes the rod self-aligning.

When the screws are not tight against the rubber, the stuffing box is free to function properly. For a further check on the fluid coming up through the bypass, the pumper may loosen the plug in the cap a little, and if the bypass is free the oil will flow immediately. If the oil does not come through, the screws in the shutoff are too tight.

When repacking Ratigan Stuffing Boxes, both rubbers must be removed. Instructions for installing are supplied to oil companies and supply stores on request, and are attached to all foreign shipments. When ordering, specify size and type of thread, and size of polished rod.

Ratigan Products Are Sold Through Leading Supply Stores. For More Detailed Information Consult The 1948 Edition Of The Composite Catalog.

J. P. RATIGAN, Inc.

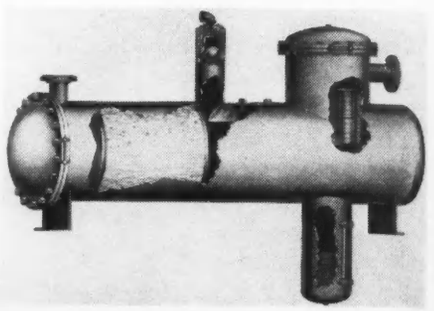
1213 Santa Fe Avenue — Los Angeles 21, California

OTHER NEW AND IMPROVED *Equipment*

62—Excel-So "FE"

The "FE," latest Warner Lewis Company separator and filter, is a combination unit and operates in three stages. The first stage removes pipe scale and other large bodies of foreign matter. The second removes particles 25 microns or larger, and the third removes particles ten microns or smaller. Other features of the "FE": water accumulator chamber, air eliminator mechanism, and built-in steam or electrical immersion heaters, if desired.

The consolidation of several primary operations into one package permits a vast saving in piping, space, fittings, ex-



tra vessels, labor, leaky connections, and duplicate concrete footings. Excel-So "FE" Separator/Filters may be designed to incorporate any or all of the features named in any capacity from 10 to 1500 gallons per minute and in any code construction up to 1000 pounds working pressure.

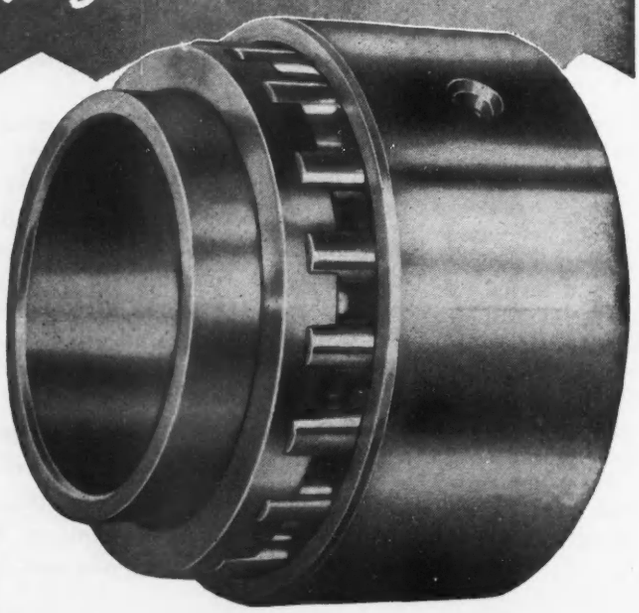
For additional information, write Warner Lewis Company, P. O. Box 3096, Tulsa, *referring to* WORLD OIL *item 62.*

American

"Extra" Heavy-Duty

Roller Bearings

for the toughest anti-Friction jobs



Here is a "super" bearing designed especially for super heavy-duty service. Its simple construction, absolute precision and tremendous strength assure smooth, dependable performance in the heaviest machinery under the most difficult operating conditions. Complete technical data furnished without obligation. Write.

AMERICAN

ROLLER BEARING CO.

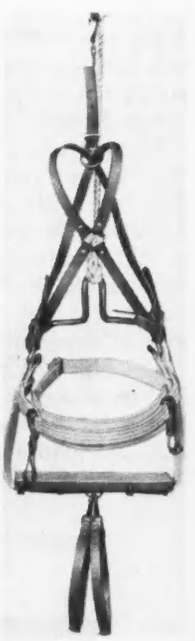
420 Melwood Street Pittsburgh, Pa.

AMERICAN ROLLER BEARINGS

Pacific Coast Office: 1718 S. Flower St., Los Angeles, Calif.

63—Safety Seat

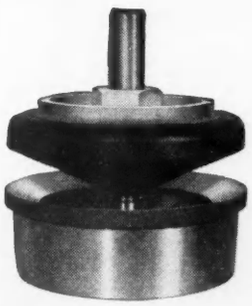
An industrial safety seat includes a rigid seat that hooks into a saddle and cannot become disengaged while in use, making a comfortable and less confining seat from which to work. The chest harness, attached to a clamp well up on the supporting rope or cable, does not interfere with a workman's freedom of motion while he is wearing it. When used in rescue work, it holds a helpless person upright in the saddle which supports him while being removed from the danger area.



It differs from other riggings used for similar purposes in the fact that when a workman has been lowered to the bottom of an enclosure, the supporting line can be slackened to permit his absolute freedom of action.

The belt is made of four-ply cotton webbing, moisture proofed and mildew resistant, securely stitched and riveted. The belt is fitted with both a ring and snap fastener for carrying tools and accessories. All dee rings are drop forged. The solid

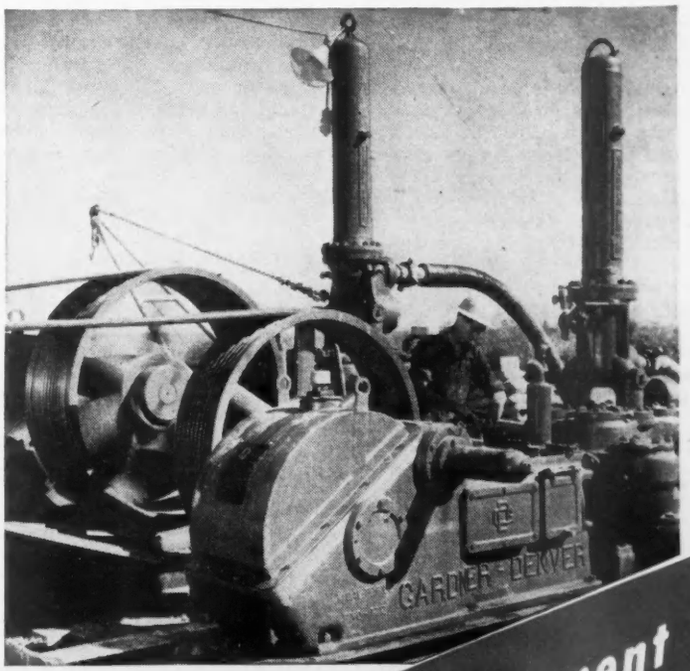
■ CONTINUED ON PAGE 258



Gardner-Denver Slush-Proof, Duo-Seat Valve — bumpers and seats of alloy steel forgings, carburized, hardened and heat treated. Rubber insert provides positive fluid seal.

Gardner-Denver Superior Slush-Proof Hardened Cylinder Liner. Heat treated to 500 Brinell. Master and reduced sizes available to meet your requirement.

Gardner-Denver Slush-Proof Hardened Piston Rod — highest grade alloy steel rods now on the market. 120,000 p.s.i. minimum tensile strength guarantees against breakage.



Gardner-Denver "FX" Power Slush Pump

Be sure it's the RIGHT Replacement

When Gardner-Denver Power Slush Pump parts worn by long and productive service need renewing, you are sure of the *right* replacement when you specify genuine Gardner-Denver Parts. Manufactured to precise specifications—of specially treated alloy steels—these parts insure you against costly production delays. Insist upon the parts designed for *your* pump . . . made only by Gardner-Denver.

For complete information, write Gardner-Denver Company, Quincy, Illinois

GARDNER-DENVER

SINCE 1859

DALLAS • HOUSTON • TULSA • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • NEW YORK • CHICAGO PITTSBURGH • DENVER • NEW ORLEANS

CONTINENTAL SUPPLY CO., CONTINENTAL BLDG., DALLAS, TEX. REPUBLIC SUPPLY CO., (of Calif.), 2122 E. 7th Street, LOS ANGELES, CALIF.

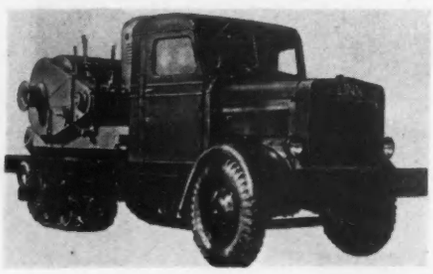
wooden seat is 15 inches long and 5¾ wide.

The safety hook is hand forged from quality steel. It is provided as a separate unit but one end of it may be permanently attached to the belt by simply closing its small eye around the dee ring. The open end is safeguarded against release, yet can be easily disengaged. The breadth of the hook and the width of the saddle permit body weight to be supported freely and eliminate any tightening of the belt around the waist.

For additional information, write Buckingham Manufacturing Company, Inc., Binghamton, N. Y., *referring to* WORLD OIL *item* 63.

64—Service Rig

A new model service rig is especially designed for mounting service winches. The mounting of service rigs on the Linn Haftrak chassis assures an all-weather, all-ground condition transport to any drilling or service location. This highly mobile unit will operate under conditions that bog down most general haulage equipment.



For additional information, write General Sales Office, Linn Manufacturing Company, 250 West 57th Street, New York 19, N. Y., *referring to* WORLD OIL *item* 64.

65—Truck Cab Ventilator

A fresh air ventilator for truck cabs (patents pending) provides additional cooling. Made from 24-gauge galvanized sheet metal and fabricated with Pittsburgh folded joints, these truck cab ventilators cause increased circulation of air through the cab. Two ventilators are attached to the cab, one on either side, and draw in fresh air which exhausts into the cab near the floor boards.

The mouth or opening of the ventilator is six inches wide and eight inches high. Location of the intake above the engine hood grill prevents the entry of hot engine fumes into the cab through the ventilator. Each ventilator is mounted to the truck cab by four bolts which hold the flanged throat of the air duct to the cab. A hole 2 x 4 inches is cut into the cab where the ventilator is bolted to the truck. The joint is sealed with weather-proofing material.

For additional information, write Evans Ventilator Company, 637 Sam Street, Houston 8, *referring to* WORLD OIL *item* 65.

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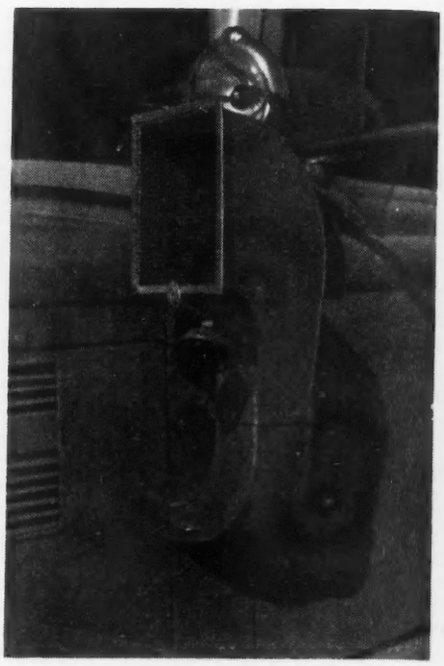
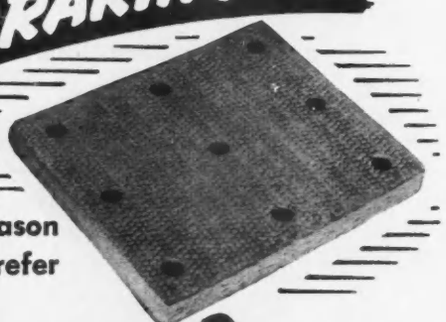


SMOOTHNESS OF BRAKING...



. . . another reason why drillers prefer

Standco NO-SMOKE BRAKE LINING

There's no grabbing when Standco Lining is used. It has a nice feed-off and slight lever pressure controls the heaviest strings of pipe.

More deep wells have been drilled with Standco than with all other blocks combined.

Be sure Standco No-Smoke Brake Lining is on all your rigs.

STANDCO BRAKE LINING COMPANY

Factory and General Offices

2701-2801 Clinton Drive Houston, Texas

NEW BEDFORD ROPE...

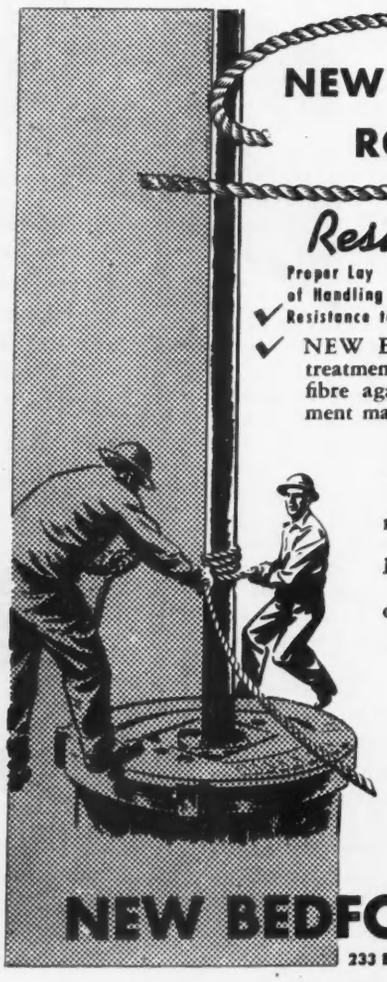
Resists weather

Proper Lay • Extra Strength • Ease of Handling • Best Manila Available • Resistance to Weather • Special Treatments

✔ NEW BEDFORD'S composite treatment for rope protects each fibre against weather. The treatment makes all NEW BEDFORD manila rope highly resistant to rotting, dryness and moisture absorption. Use NEW BEDFORD manila for cable tool lines, bull ropes, crackers, cat lines, torpedo lines, spinning lines, or any other oil field use.

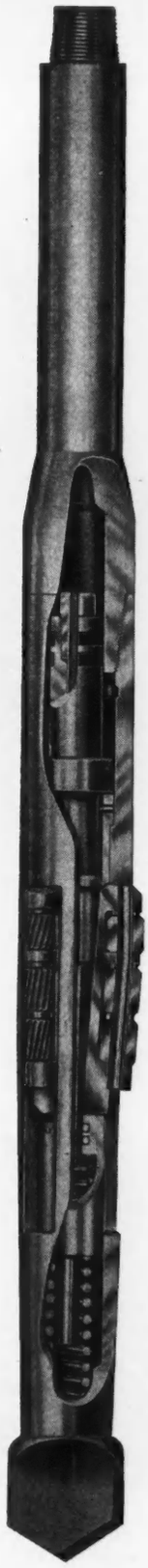
✔ Resistance to weather is only one of six good reasons why New Bedford Cordage is better for every use. All six are found in all NEW BEDFORD ropes.

FREE: Write today for handy booklet on knots, rope splicing and whipping.



NEW BEDFORD CORDAGE COMPANY

233 BROADWAY, NEW YORK 7, N. Y.



GRANT
Roller Cutter
Underreamer

Here's Real Insurance for Successful Liner Jobs —THE GRANT UNDERREAMER!

Cutter expansion is positive. Multiple cutters insure a shearing and slicing action that cuts a smooth, full-gauge hole all the way. Simply pulling up against the shoe collapses and resets the cutters whenever desired.

The Grant Roller Cutter Underreamer is famous the world over for its trouble-free operation, efficient reaming action and rugged, safe construction under the toughest well conditions. *For all underreaming work, in any formation, you get safe, sure liner and casing landing jobs with a Grant.* Write for Bulletin 24 giving complete details, and contact the Grant representative nearest you!

Proven GRANT Tools
Used Where Performance Counts

Hydrostatic Bailers	Bulletin No. 11
Liner Pullers	Bulletin No. 14
Pressure Releases	Bulletin No. 15
Casing Scrapers	Bulletin No. 17
Wall Scrapers	Bulletin No. 20
Bottom Hole Scrapers	Bulletin No. 21
Underreamers (Rotary)	Bulletin No. 24
Underreamers (Cable Tool)	Bulletin No. 27
"Forjaloy" Hole Enlargers	Bulletin No. 38
Reamers	Bulletin No. 43
Hydrostatic Perforation Cleaners	Bulletin No. 50
Dump Bailers	Bulletin No. 51
Roller Cutter Shale Bits	Bulletin No. 54
Sand Pumps	Bulletin No. 55
Impression Block Tool	Bulletin No. 56
Well Cleanout Equipment	Bulletin No. 57

Write for Descriptive Bulletins on these GRANT Tools

GRANT
OIL TOOL COMPANY

Main Office and Plant: 2042 East Vernon, Los Angeles 11, California
Branches at Bakersfield, Avenal and Ventura, California,
and at Odessa and Houston, Texas

66—Lugger Crane

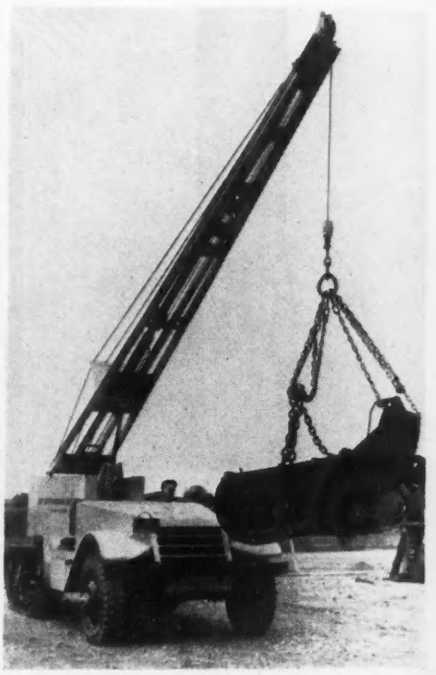
The lugger crane is a highly versatile and mobile hydraulic unit which is said to provide exceptional utility at low cost.

The crane lifts and carries up to 6000 pounds. Ten feet of vertical boom travel is provided, with a corresponding cable travel of 16 feet. Maximum clearance under hook is 18 feet, 6 inches. Sidewise movement of the boom is limited to assure stability when handling maximum loads, even with unskilled operation.

All movements of the crane are readily controlled by one man from the driver's seat through a simple system of precision Daybrook hydraulics. It is claimed that any man who can drive an automobile can be taught to operate the crane within a few hours as a result of this simple operating arrangement.

The half-track chassis works effectively on almost any kind of terrain from factory floor to rutted mud, and operates at speeds of up to 40 miles per hour. In addition to lifting and carrying, the chassis is also equipped to perform a variety of towing and pushing operations.

For additional information, write Day-Smith Hydraulic Crane Corporation, Camp Hill, Pa., *referring to* WORLD OIL *item* 66.



Man to Man

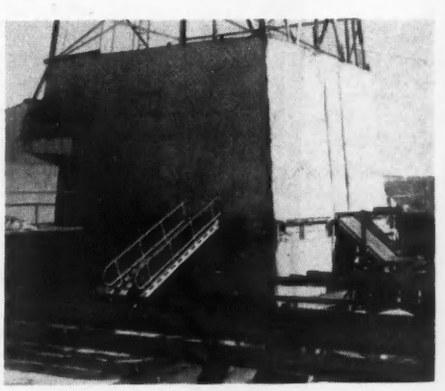
The Republic has a thorough working knowledge of the oil industry ... coupled with ample resources to handle the needs of the oil man.

REPUBLIC
NATIONAL BANK of DALLAS
CAPITAL & SURPLUS $25,000,000 LARGEST IN THE SOUTH

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

67—Rig Cover

A plastex substructure cover for drilling rigs goes a step further in affording weather protection for drilling crews and equipment. It increases comfort on the drill floor and prevents connections under the floor from freezing.



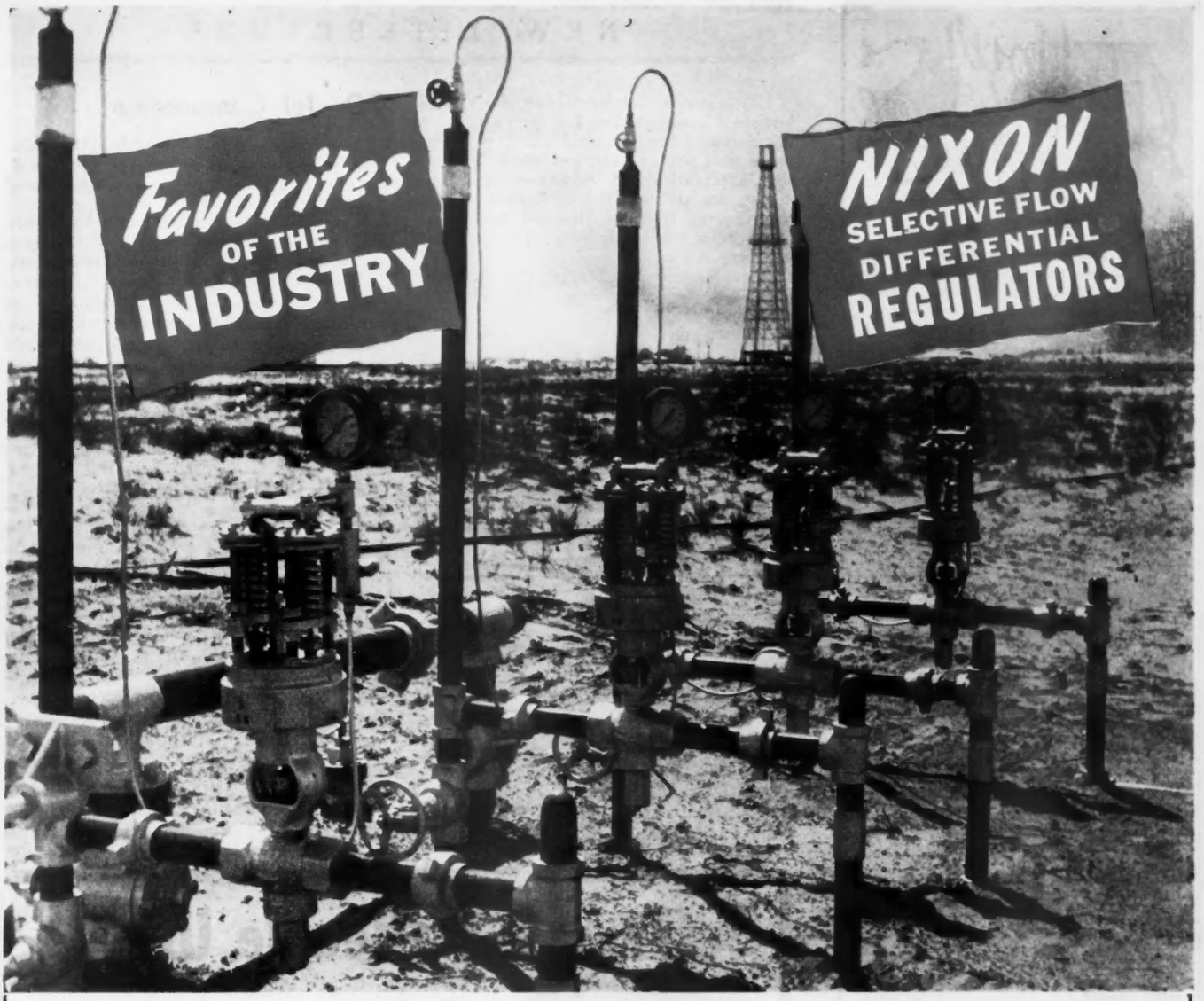
For additional information, write Lewis Manufacturing Company, P. O. Box 1451, Oklahoma City, *referring to* WORLD OIL *item* 67.

NEW LITERATURE

68—Self-Cleaning Strainers

An eight-page, two-color, illustrated booklet describes various self-cleaning strainers.

■ CONTINUED ON PAGE 262



NOW—with the "QUICK CHANGE" BALL VALVE and SEAT ASSEMBLY

The main gas control valve in the new type Nixon Regulator, is a Ball Valve and Seat assembly which can be changed in the field, by the use of one small wrench, in only a few minutes. This eliminates the necessity of sending the Regulator to the shop for repairs.

The photograph above shows a string of four of some forty Nixon Regulators, used by the Richardson-Bass Oil Company, in the Keystone field, Winkler County, Texas.

For Pressure Reducing; Back Pressure work; Stop Cocking and Well Purging—YOU can depend on the Nixon Selective Flow Differential Regulator.

Contact your nearest Wilson Supply Company Store—or write the Houston office for complete information on this worthwhile product.

WILSON SUPPLY COMPANY

1412 MAURY ST., HOUSTON, TEXAS

SALES OFFICES: Tulsa, Oklahoma; Dallas, Texas.
LOS ANGELES: Western Pressure Control, 5700 Santa Fe Avenue.

BRANCH STORES: TEXAS—Kilgore, Beaumont, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi, Columbus. LOUISIANA—Lake Charles, New Iberia, Harvey, Shreveport. ARKANSAS—Magnolia. MISSISSIPPI—Natchez.

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Always at your service with the most modern facilities for your personal comfort ... that's the policy of all Affiliated National Hotels. For conventions, business trips, vacations, or dining out, we hope you'll make it a habit to choose a National Hotel whenever you're in one of the twenty-one "National" cities.

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HOTEL LAMAR ..... Meridian
NEBRASKA
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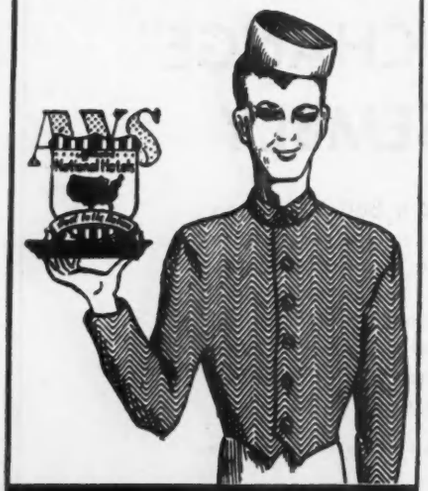
CORONADO COURTS ..... Galveston
JACK TAR COURT HOTEL ..... Galveston
MIRAMAR COURT ..... Galveston
HOTEL CAVALIER ..... Galveston
HOTEL PLAZA ..... Laredo
HOTEL LUBBOCK ..... Lubbock
HOTEL FALLS ..... Marlin
HOTEL CACTUS ..... San Angelo
HOTEL MENGER ..... San Antonio
ANGELES COURTS ..... San Antonio
VIRGINIA
HOTEL MOUNTAIN LAKE ..... Mountain Lake



Affiliated
NATIONAL HOTELS
EXECUTIVE OFFICES
GALVESTON, TEXAS

NEW LITERATURE

Illustrations show several typical strainer installations for protection of regulators, regulating valves, stop valves, traps and process equipment, as well as the application of strainers to drain steam, air and gas lines. Strainer screen interchangeability is stressed and standard screen materials are listed for various applications.

Tables showing screen specifications and total free hole areas facilitate the selection of the correct screen for different services.

Dimensions of cast iron, cast bronze, cast steel and stainless steel strainers are shown in tabular form beside line drawings of each type of strainer. A large chart, plotting saturated and superheated steam flows show pressure drops through Leslie self-cleaning strainers for various pressures and temperatures.

Published by Leslie Company, 167 Delafield Avenue, Lyndhurst, N. J.

69—Compensator Applications

Bulletin COM-1 presents diagrams of typical compensator applications and installations; gives data on compensator working pressures and standard end fittings; and contains much more helpful information for those working with piping which is subject to corrosion, expansion, temperature, deflection, movement, vibration and other conditions.

Published by Chicago Metal Hose Corporation, Maywood, Ill.

70—Jet Compressor

A 12-page catalog describes the various-type steam and gas jet compressors, as well as their construction and operation.

Tables and drawings give complete information on dimensions, connection sizes, and weights of the different types. Colored diagrams with detailed explanations describe typical applications of jet compressors in numerous industries, such as paper-making, vulcanizing, various chemical industries and gas plants.

Published by Schutte and Koerting Company, 12th and Thompson Streets, Philadelphia 22.

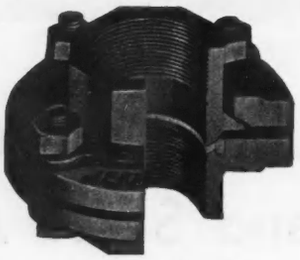
71—Conveyor System

Information necessary for laying out a belt conveyor system is contained in a bulletin on Robins Idlers. Bulletin 120-A1 amplifies the previous issue, incorporating important changes in engineering details. It also points out features of the Robins Idlers, such as one-shot lubrication, triple grease seal, rigid truss construction, malleable iron brackets, channel bases, minimum clearance between pulleys and uniform wall thickness of pulleys.

Published by Robins Conveyor Division, Hewitt-Robins, Inc., Passaic, N. J.

• CONTINUED ON PAGE 264

Jefferson Malleable Unions



STYLE "B"

JEFFERSON Style "B" three-piece flange union is made with brass-to-iron and iron-to-iron seats. Being made of highly refined AIR FURNACE iron, it assures you of lightweight construction, perfect ball joint, and positive seating arrangement, whether or not in alignment.

★ ★ ★

HYDRAULIC PRESSURE RATING

Sizes	Test Pres.	O. W. G.	S.W.P.-550 Deg.
½" thru 4"	2000#	800#	250#
5" and 6"	1200#	500#	250#
8" and 10"	1000#	400#	250#

Malleable iron used in all JEFFERSON unions meets ASTM-4733, Grade 35018—M. T. 53000 Lbs., giving 75%-more elongation 50%-more impact value and is 30%-stronger than cupola malleable iron.

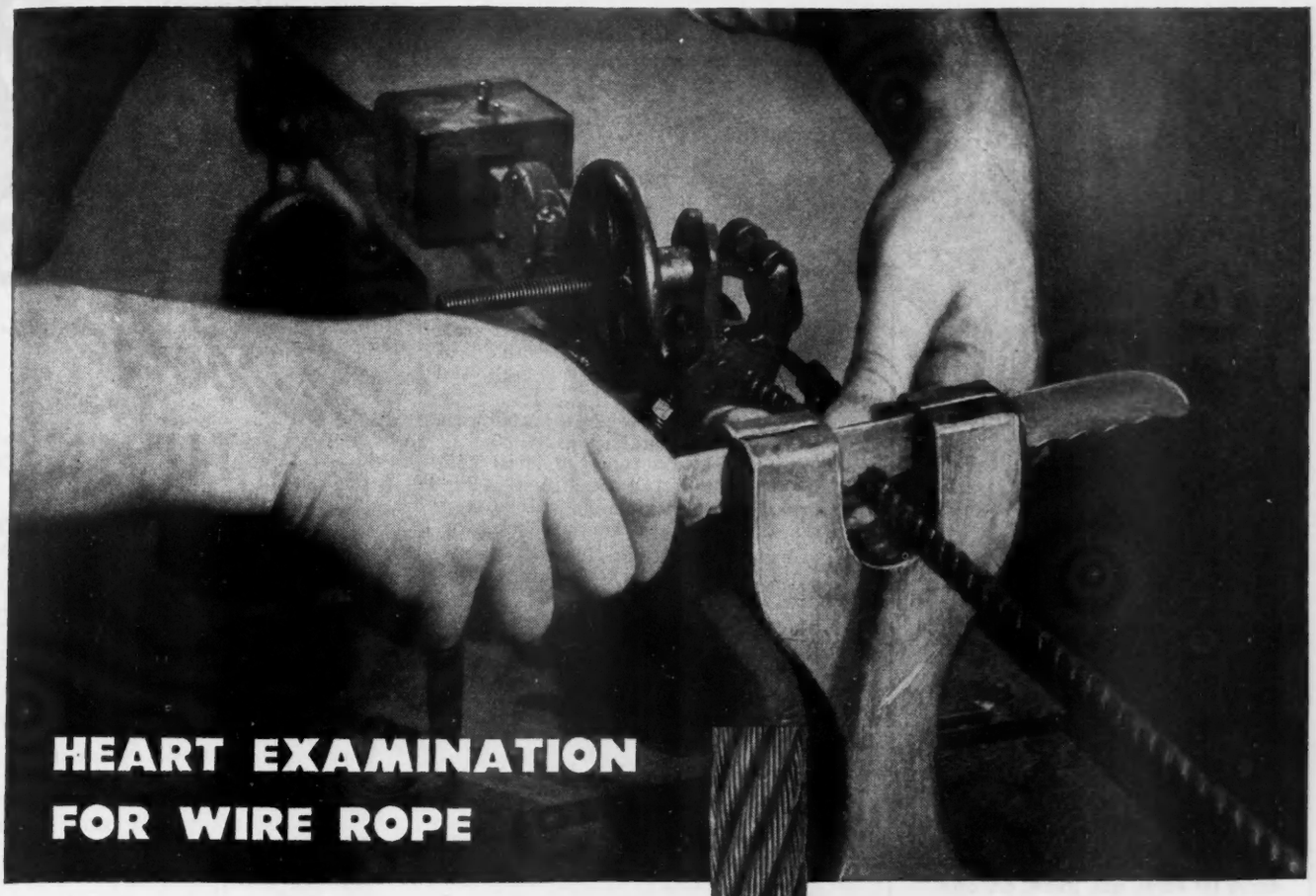
Obtainable through your jobber

Jefferson Union Company, Inc.

691 West 26th St.,
New York 1, New York

71 Gooding St.,
Lockport, New York

31 Fletcher St.,
Lexington, Mass.



HEART EXAMINATION FOR WIRE ROPE

The fiber core in the heart of wire rope serves a fourfold purpose. It acts as a support for the wire strands. It provides flexibility. It cushions impact loads. It stores lubricant and feeds it to the strands during the life of the rope.

Because of these important functions, the centers used in Wickwire Rope must pass exhaustive tests at the cordage manufacturer's plant and in Wickwire's Testing Laboratory. Centers must be made of the highest quality fiber; absolutely uniform in diameter, density and length of lay. The rope must be lubricated to the point of saturation and, where called for, an identifying marker tape must be spun into the rope.

Tough specifications? Sure! But so are scores of other tests made during the manufacture of Wickwire Rope. That's why more and more rope users are finding out that you can't beat Wickwire Rope for performance, safety and long rope life. And as for service—Wickwire Distributors and Wire Rope Engineers in key cities everywhere are ready to help solve your wire rope problems and to provide prompt delivery of Wickwire Rope from strategically located warehouse stocks. Wickwire Rope is available in all sizes and constructions, both regular lay and WISSCOLAY *Pre*formed.

HOW TO REDUCE ROPE COSTS AND PROLONG ROPE LIFE

Thousands of wire rope users have found that the information packed in the pages of "Know Your Ropes" has made their work easier. It's full of suggestions on proper selection, application and usage of wire rope. It's easy-to-read and profusely illustrated. For your free copy, write — Wire Rope Sales Office, Wickwire Spencer Steel, Palmer, Mass.

WICKWIRE ROPE

A PRODUCT OF THE WICKWIRE SPENCER STEEL DIVISION OF THE COLORADO FUEL AND IRON CORPORATION

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"Red Wheel"
VALVES, HYDRANTS
And Pipe Line Accessories

M & H valves are used in the oil industry for water, gas, steam, oil, chemicals and are furnished in all commercial sizes from 2" to 30", inclusive. They are cast iron body, bronze mounted, furnished double disc parallel seat or solid wedge. They are heavily proportioned and have a high factor of safety.

A. W. W. A. HYDRANTS
Underwriters Approved

Conform to American Water Works Association Specifications. Approved and listed by Underwriters' Laboratories and Associated Factory Mutuals. Well known and widely used for many years.

SPECIAL TRAFFIC MODEL is designed to yield at ground line under impact, repair being simply renewal of breakable bolts and breakable coupling on stem. High efficiency because barrel diameter not reduced and there are no working parts or obstructions in waterway.

OTHER M & H PRODUCTS

Fire Hydrants
Gate Valves
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Check Valves
Floor Stands
Extension Stems
Mud Valves
Flap Valves
Sludge Shoes

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

NEW LITERATURE

72—Link Belt Catalog

New sizes and types of enclosed herringbone gear units for speed reducing and speed increasing service, are detailed and described in a new Book No. 1819 of 68 pages.

The book includes reducer selection data and examples of proper application; dimensions and horsepower ratings; lubrication data; and tables of maximum allowable pull on high and low speed shafts.

Pages 46 to 59 show photographs of a great variety of installations. Gear-type flexible roller chain types of shaft couplings are listed and described. There is also a page of detailed information on the Link-Belt differential back stop.

Published by Link-Belt Company, 2045 W. Hunting Park Avenue, Philadelphia 40, Pa.

73—Compressors

A leaflet descriptive of the new Air Chief line of industrial air compressors contains mechanical data and specifications on complete Davey departmental units of 60-105-160-210 and 315 cubic feet per minute capacities. It also lists bare compressors suitable for installation with customer's motors or as replacement machines.

Advantages of the "departmental" or "at - the - job" compressor system, as originated 20 years ago by Davey, are described in detail. Under this plan, each factory department has its own compressor operated in accordance with its individual requirements.

Published by Davey Compressor Company, Kent, Ohio.

74—Engines

An eight-page brochure describes two-cycle Series 1200 die-cast industrial gasoline engines, from 2½ to four horsepower. Details on standard engines now in mass production are given, as well as information on special engines which the company is prepared to design and mass-produce for a wide variety of customer applications in the transportation, marine, implement, aircraft - auxiliary, and other fields.

Published by McCulloch Motors Corporation, 6101 W. Century Blvd., Los Angeles 45.

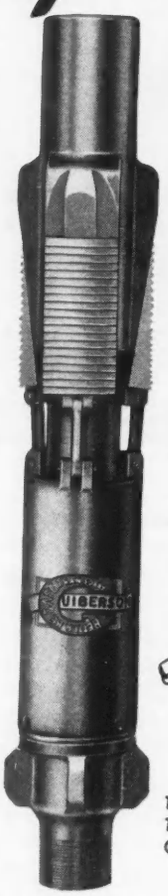
75—Bearings

Information about light series pillow blocks, flange cartridges and cylindrical cartridges equipped with sealed wide inner ring ball bearings is contained in an eight-page folder. The units described are widely used for carrying light or normal loads in applications where simplicity of installation is an important factor. Photographs, sectional drawings, specifications and load ratings are included.

Published by The Fafnir Bearing Company, New Britain, Conn.

Safeguard TUBING
with Guiberson
TUBING CATCHER

Stops the parted tubing before it falls 3 inches, without damage to casing walls. Releases easily and quickly and has large fluid and gas bypass area. Hangs free until tubing drops. Large area slips grip the casing wall firmly without distorting casing.



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Type "E" Tubing Catcher

Type "B" Tubing Catcher

Three types with or without anchors for all sizes and weights of casing: Made in Type "E" with 3 slips for wells to 11,000 feet, Type "B" with 3 slips for wells to 7,200 feet, and Type "F" with 6 slips for extremely deep wells.

For complete data see the Composite Catalog, page 1528-32 or write to

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Associations

API OFFICERS—District officers of the Southwestern District of the American Petroleum Institute are, left to right, L. H. Dial, vice chairman for East Texas, East Texas Salt Water Disposal Company, Kilgore; O. W. Van Dyke, secretary-treasurer, Magnet Cove Barium Corporation, Houston; R. E. Bridges, chairman, Humble Oil & Refining Company, Houston; B. J. Dowd, chairman of advisory committee, Union Producing Company, Shreveport, La.; and R. B. Saxe, vice chairman for West Texas and New Mexico, Gulf Oil Corporation, Odessa, Texas.

Mid-Continent ASME Elects John H. Keyes Chairman

John H. Keyes has been elected chairman of the Mid-Continent Section of the American Society of Mechanical Engineers for 1948-49. Other officers chosen are Allan A. Hardy, first vice chairman; Paul G. Exline, vice chairman programs; and Guy F. Williams, secretary. Second vice chairmen are Professor Frank S. Roop, Norman-Oklahoma City district; Professor Rollo E. Venn, Stillwater-Ponca City district; Professor R. G. Paddock, Arkansas district; Leonard P. Mead, Bartlesville district; L. Wood Jackson, Amarillo district; and James T. Carmichael, North Louisiana district. Members of the executive committee are Clarence H. Blue, Wayne C. Moody, D. A. Cant, and R. A. Coglin.

J. D. Davis Elected Chairman Of Engineering Committee

J. D. Davis, Union Producing Company, has been elected general chairman of the Mississippi Oil and Gas Engineering Committee. J. S. Boldrick, Humble Oil & Refining Company, is general vice chairman, and Paul F. Barnhart, Frank and George Frankel, is secretary-treasurer.

Members of the executive committee are D. V. Carter, Magnolia Petroleum Company; W. F. Dalton, Hunt Oil Company; W. F. Eiting, Jr., The Carter Oil Company; B. W. Haywood, Gulf Refining Company; J. E. Howell, Lion Oil Company; J. T. Reynolds, Sohio Petroleum Company; and A. S. Rhea, Sun Oil Company, chairman of the committee.

IPAA Meeting Scheduled for San Antonio September 27-28

San Antonio will be the site of the annual meeting of the Independent Petroleum Association of America September 27-28. Headquarters will be in the Plaza Hotel.

Oil producers attending the sessions will analyze the tremendous demand for petroleum products, and the drilling and development program of the industry to supply the crude necessary to meet these demands. The question of adequate materials for equipping wells, particularly steel and other tubular goods, will be a paramount consideration. Other topics scheduled for discussion are natural gas, exploration, and a program of information on oil industry activity and development.

Walter A. Henshaw, Henshaw Brothers, independent producing firm of San Antonio, has been named chairman of the general arrangements committee, assisted by Fred W. Shield and L. A. Nordan, cochairman, both of San Antonio.

Jerry Upp Elected President Of Tulsa Geological Society

Jerry E. Upp of Amerada Petroleum Corporation has been elected president of the Tulsa Geological Society. Other officers are: W. Reese Dullard, consulting geologist, first vice president; Noel Evans, consulting geologist, secretary-treasurer; and John C. Maher, U.S.G.S., editor. Members of the council include E. O. Markham, The Carter Oil Company; J. B. Leiser, Shell Oil Company; and Russell Tarr, consulting geologist.

Oil Producers Agency Elects L. A. Cranson President

L. A. Cranson, executive vice president and a director of Honolulu Oil Corporation, was elected president of Oil Producers Agency. Cranson succeeds W. C. Whaley, vice president and manager of Barnsdall Oil Company's California operations.

Other officers are H. E. Woodworth, first vice president, Safe Oil Company, Bakersfield; R. A. Grant, second vice-president, Fullerton Oil Company, Los Angeles; C. C. Spicer, third vice president, Republic Petroleum Company, Los Angeles; and C. A. Johnson, fourth vice president, Holly Development Company, Los Angeles.

Rush M. Blodgett, executive vice president for 18 years, was reelected, as were W. Russell, secretary-treasurer, and Verne Harrell, assistant secretary-treasurer.

Directors are J. M. Feldman, Ralph B. Lloyd, D. T. Staples, H. E. Woodworth, R. H. Garrison, M. A. Machris, C. P. Watson, Roy W. Young, James H. Lewis, L. K. Whittier, and Charles T. Wilson.

Texaco Old-Timers Receive Service Awards at Dinner

Veteran employes of The Texas Company and The Texas Pipe Line Company received service awards at the annual dinner of the Texas Old-Timers Club in Houston April 12. Fifty-one employes with 30 years of service each were presented gold watches and 31 employes with 25 years of service each were given service emblems.

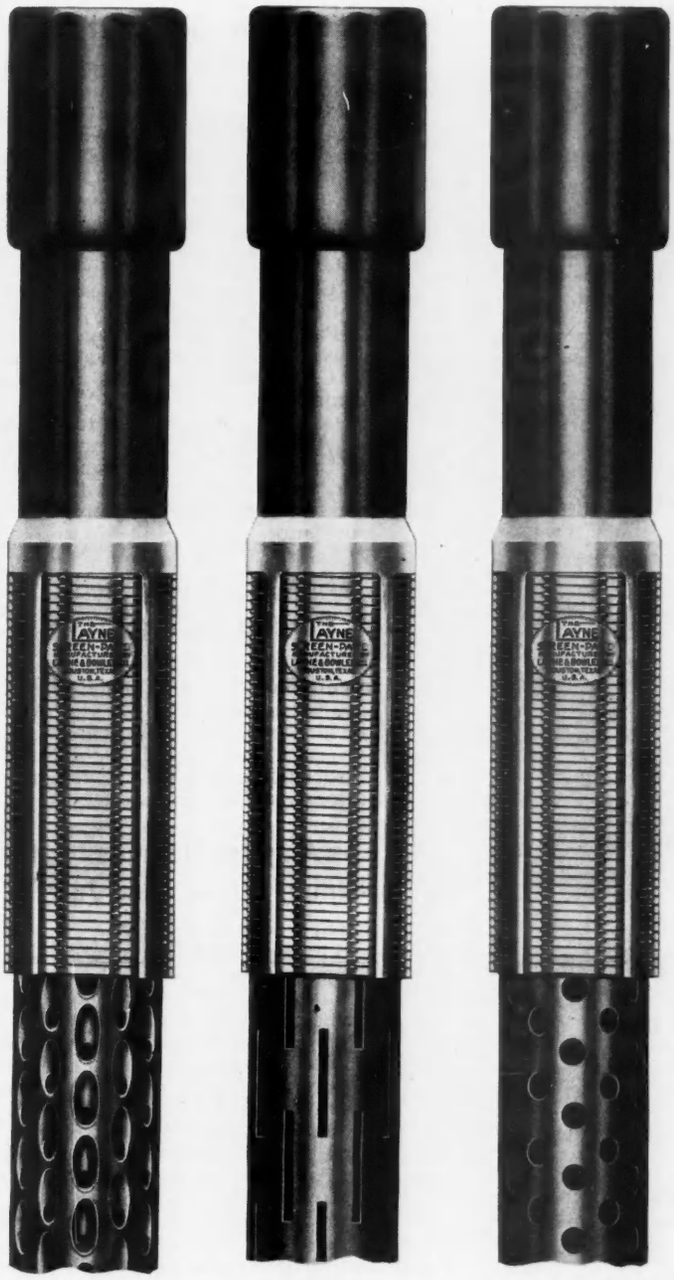
E. R. Filley was elected president of the Old-Timers Club. Other officers elected were David Coleman, O. V. Summers, and O. M. Webb, vice presidents; J. W. Forrest, secretary; and Arthur Lefevre, Jr., treasurer.

C. B. Barrett, Manager of the South Texas division, presented the awards in the absence of J. S. Leach, vice president and general manager of The Texas Company.

The Houston dinner was one of 29 service award dinners held throughout the country in April and May, at which 366 employes received 30-year gold watches and 620 employes were awarder 25-year service pins.

Penn Grade Crude Group To Meet in Pittsburgh June 17

The Pennsylvania Grade Crude Oil Association will hold its annual meeting June 17 at Hotel William Penn, Pittsburgh. The non-profit organization, composed of producers, refiners and marketers of Pennsylvania oils, will celebrate the 25th anniversary of its founding.



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Fenton, Blodget Appointed To National Petroleum Council

Secretary of the Interior J. A. Krug anounced the reappointment of Richard Fenton, executive vice president of the California Stripper Well Association, Los Angeles, and the appointment of Rush M. Blodget, executive vice president, Oil Producers Agency of California, Los Angeles, to the National Petroleum Council.

Max W. Ball, director of the Oil and Gas Division, announced the appointment of John E. Boice as petroleum transportation specialist. With the exception of nearly four years spent with Petroleum Administration for War as a senior transportation engineer, Boice has been with Interstate Commerce Commission since 1912 in a variety of positions.

Gas Group Elects

W. H. Ligon, president of Nashville Gas and Heating Company, Nashville, Tenn., has been elected president of the Southern Gas Association, succeeding W. Lee Woodward, president of Zenith Gas System, Woodward, Okla.

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Marion J. Moore to Head South Texas Geologists

Marion J. Moore, district geologist for the Sunray Oil Corporation, San Antonio, was elected president of the South Texas Geological Society for the 1948 term. Other newly-elected officers are Paul B. Hinyard, Shell Oil Company, vice president; and Maurice E. Forney, The Atlantic Refining Company, secretary-treasurer.

Members of the executive committee are Guy E. Green, vice president of The Santa Clara Oil Company, and Leland L. Palmer, division manager in charge of exploration of the Texas division of W. C. McBride, Inc. Both are from San Antonio.

District representatives to the American Association of Petroleum Geologists are George E. Coates, independent operator, and Robert S. Mann, district geologist for Shell Oil Company, both from San Antonio.

C. F. McLaren Elected By Purchasing Agents

C. F. McLaren, Tulsa area purchasing agent, Shell Oil Company, was elected vice president of District Two of the National Association of Purchasing Agents. He is a past president of the Tulsa Association and has long been prominent in local and district affairs.

Los Angeles Nomads to Have Annual Whing Ding July 16

The Los Angeles Chapter of Nomads will have their ninth annual Whing Ding July 16 at the Lakewood Country Club in Long Beach. The schedule of events includes a golf tournament, horseshoe pitching tournament, gaming, dinner, and floor show.

Committee chairmen are George L. Trembley, golf committee; Ray M. Humphreys, game committee; Abe Haglund, horseshoe committee; and George M. Anderson, prize committee.

Arrangements for the Whing Ding were announced at the April meeting, at which John Dodge, former professor of petroleum engineering at the University of Southern California, was the speaker. Recently returned from a tour of duty with Pantepec Oil Company in Venezuela, he spoke on conditions in that country, revealing some of the difficulties that operating companies are experiencing with extremely high royalties, financial problems, and labor policies.

Hammond Elected Chairman Of Mid-Continent AIME

John P. Hammond, Amerada Petroleum Corporation, Tulsa, was elected chairman of the Mid-Continent section of the American Institute of Mining and Metallurgical Engineers for 1948-49. Other officers are J. Murray Walker, Lane-Wells Company, first vice chairman; Russell H. Gwinner, Sunray Oil Corporation, second vice chairman, and Roy H. Smith, Stanolind Oil and Gas Company, secretary-treasurer.

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ROOFE SWIVEL JOINTS

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650 Persons Attend Annual Petroleum Pioneers' Broilecue

Six hundred and fifty persons attended the annual "broilecue" of the Petroleum Production Pioneers organization held in April at the Union Oil Company picnic grounds near Brea. Presently boasting a total membership of nearly 900 persons, the fast-growing organization is expected to have 1000 members by the end of this year.

Organized in 1944 in Los Angeles, the group has two types of membership—pioneers and juniors. To be eligible for the former, a member must have been engaged for at least 30 years in the business of drilling or producing oil wells or in activities directly associated with such work. To be eligible for junior membership a person must have had at least ten years experience in such activities.

Annual Spring Meeting of API Attended by 932 Oil Men

Registrations totalling 932 were tabulated during the May 6-7 annual spring meeting of Pacific Coast District of American Petroleum Institute, held in Los Angeles. The banquet, at which Harold Sheets, past chairman of the board, Socony-Vacuum Oil Company, spoke on "The Middle East," was attended by 1142 oil industry representatives.

Pacific Coast District, Division of Production officers elected to serve for 1948-49 are Lot Bowen, chairman, Western Gulf Oil Company; H. O. Woodruff, vice chairman, L. A. Basin District, The Texas Company; D. G. Kingman, vice chairman, San Joaquin Valley District, General Petroleum Corporation; T. H. Rodgers, vice chairman, Coastal District, Chanslor-Canfield Midway Oil; Cal Townsend, vice chairman, Coalinga-Kettleman District, Standard Oil Company of California; W. G. Corey, treasurer, Lacy Oil Tool Company; and Mrs. Elsie M. Edmiston, secretary, American Petroleum Institute.

Some of the important papers presented are abstracted below, as follows:

Achievement of Mobility In Drilling Units

By W. F. BATES and J. N. GREGORY, Shell Oil Company, Incorporated, Los Angeles.

It is believed that the subject of mobility should be divided into two distinct phases: 1) the design and layout of drilling equipment, and 2) the scheduling of the drilling program which determines hoisting and circulating requirements, and thus the sizes and weights of equipment to be employed. Some of the more important fundamentals which must be considered if mobility is to be achieved are: (1) All component parts of a drilling rig, including the derrick, should be portable. (2) Individual loads should be legally portable, both in weight and bulk. (3) Whenever economical, units of equipment should be mounted on wheels. (4) Assembly work at the rig site must be kept to a minimum by grouping pieces of equipment into the largest legally portable units possible. (5) Provision must be made for handling heavy loads readily. (6) The requirement for accurate alignment between individual units must be kept at a minimum.

The design of smaller drilling units is closely related to the second phase of mobility achievement. In this phase, concerning hole and drill pipe size, there is a great deal of room for experiments and improvements in technique and equipment. Through the use of slim holes, considered to be 6¾-inch size, it is possible to use smaller pumps and drill pipe. A reduction of the latter automatically reduces hoisting equipment requirements and, therefore, offers the greatest challenge insofar as overall reduction of size of equipment is concerned. Conversely, a reduction in drill pipe weights permits drilling deeper with available lightweight portable equipment. To reduce this theory to practice, a trial was made of 8000 feet of regular 3½-inch upset J-55 tubing weighing 9.3 pounds per foot with acme-threaded collars.

Application of Hydraulic and Pneumatic Devices to Drilling Equipment

By NICHOLAS A. D'ARCY, Consulting Mechanical Engineer, Huntington Park, Calif.

Hydraulic and pneumatic devices have found widespread use in the construction of drilling equipment from the single engine power rigs up to the largest power and steam drilling units. The most important functions performed by hydraulic devices on a large number of rigs are hydromatic braking; hydraulic coupling drives to the drawworks and slush pump; torque converter drives to drawworks and special purpose pumps; and in smaller numbers, the new combination hydraulic torque converter and coupling on drawworks and pumps.

Among the important pneumatic devices used on many drilling rigs are air clutches in which the air pressure forces the friction material against the driven portion, air operated drill pipe slips, and, in some cases, air operated drill pipe tongs. Power drawworks brakes give promise of being the next major application of pneumatic and hydraulic power. Several remote-controlled drawworks brakes are now depending upon these fluids for their operation.

The Oil Industry and Politics

By A. C. MATTEI, President, Honolulu Oil Corporation, San Francisco, Calif.

The current greatly increased demand for oil may be, in large part, directly charged to the coal industry's deficiency in maintaining its share of increased fuel demands. Its labor troubles account in major part for the flight from coal to oil. Prices of coal now have become noncompetitive with oil and this, together with strikes, has caused users to resort to a more dependable fuel.

To show what has been taking place in the fuel field over a longer period, consider the shift in the sources of our

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energy requirements in the United States since 1918. At that time coal supplied over 80 percent of the total energy requirements. Of the amazing growth in our nation's energy consumption since then, 95 percent has been supplied by increases in oil and natural gas output; 5 percent has been supplied by water power. Over this 29-year period, coal production has shown no gain, whereas oil production has increased five-fold and natural gas even more. Criticism might justly be leveled against industries that have held back on expansion or that have fallen far short of demand, but the oil industry does not fall in either category. It is necessary that this story be told so that people may not blame us for the shortcomings of others. By proper appraisal and effective action, we in the oil industry can materially aid the coal industry, as well as ourselves, by supporting corrective legislation.

It is recalled that but a few years ago oil company properties in Mexico were expropriated and nationalized. The experiment was not a success, so now the door is being opened slowly, and too cautionsly, to American nationals who desire to go to Mexico for petroleum exploration and production operations. Ultimately, for the good of every one concerned, Mexico's potential oil fields should be developed. This applies also in Bolivia, where American capital again is being sought for oil development.

There are many things necessary to our future success as an industry, such as the necessity for technical progress to stretch and to augment our reserves. These things will come and we will continue to progress so long as we have a free industry and a free economy in which to operate.

A Subsurface Flow Rate Indicator and Its Application

By F. M. CARLISLE, International Cementers, Inc., Long Beach, California.

It has long been a problem in oil production to locate zones of fluid ingress and egress. This is also true as regards drilling of wells where lost circulation is a problem. In the original completion of wells the relative permeabilities of streaks and zones are indicated by a variety of suitable instruments. However, as the life of a well progresses, these indicated relative permeabilities may and usually do change, due to a variety of factors. The apparatus described is the outgrowth of a desire for additional information on the point of entry and rate of flow of fluid within the well bore. The equipment is essentially a turbine, the rotor or runner of which is turned by fluid movement in either direction. The rotation of the runner interrups an electric circuit and these interruptions are indicated at the surface on an electronic indicator and counter. The electric current is carried in a single conductor armored cable similar to that used in gun perforating. The surface indicator and counter is a vacuum tube circuit which will indicate as high as 3600 interruptions per minute.

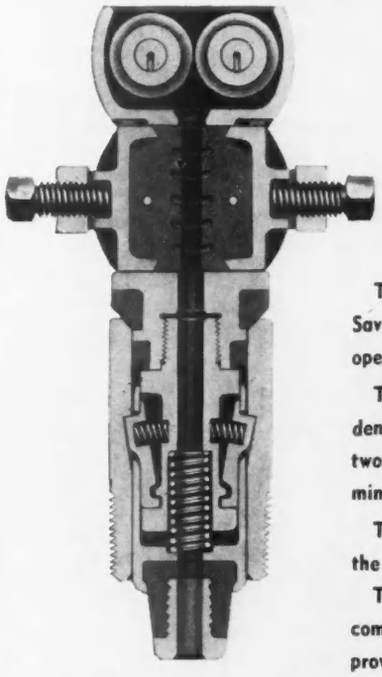
Results to date indicate that many subsurface anomales exist which are not suspected from surface conditions existing at the time. The apparatus described will indicate the following conditions within a well: (1) lost circulation even though there may be two or more intervals simultaneously taking fluid; (2) holes in pipe, provided fluid may be pumped into them or that fluid is emerging therefrom at a rate above the minimum velocity of three feet per minute in the pipe; (3) the relative permeability of producing intervals of wells while in the producing state; (4) the relative permeability of the different intervals in wells in an injection project, whether the injected liquid medium be gas or liquid; and (5) the location of points of entry of gas in wells that have an abnormally high gas-oil ratio.

Some Limitations of Rod Pumping

By KENNETH T. McCAMMAN, Shell Oil Company, Incorporated, Bakersfield, Calif.

In considering rod fall, strengths of sucker rods, tubing, pumping units and pumps as they affect the amount of fluid that can be pumped from any depth, the author concludes that (1) the speed with which rods and plunger will fall limits production from depths less than

For Swabbing Operations



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Type 3AR King Wire Line Stripper (often called "Oil Saver") is the ideal tool to use in connection with swabbing operations.

The positive latch and sure release insure against accidents and eliminate the possibility of jerking a wire line in two. The non-sparking materials used in its construction, minimize the fire hazard.

The packing is inserted from the sides of the tool and the tool can be repacked while the line is in the hole.

The roller line guides center the line and outlast the more commonly used bushing many times. Grease nipples are provided to lubricate the guide rollers. Convenient hand holds contribute to easy handling of the tool. *This tool is constantly coming into greater use.* A trial is convincing.

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The Type 4AR Stripper is similar to the Type 3AR, except it is a little larger. It is commonly used in connection with the Type 4C King Circulating Head. It can be, and sometimes is used with other makes of circulating heads.

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1700 feet; (2) the operating strength of sucker rods is the primary limiting factor on production from depths over 1700 feet; tubing, pumping units, and pumps appearing sufficiently strong to permit full utilization of the working strength of rods; and (3) the development of 40,000 psi working strength rods, which now seems assured, has more than doubled the productive capacity of the rod pumping system from depths below 9000 feet, and has lowered the limiting factor of rod type equipment to approximately 15,000 feet.

It is noted that at all depths the longer stroke length permits a higher production rate, although the shorter stroke length is run at a faster speed. This is due to the fact that the plunger accelerates for approximately one-half the stroke length; the longer stroke therefore can have a faster maximum and average speed, and a greater displacement. Pumping cannot be done from below about 11,500 feet with rods stressed to 30,000 psi. regardless of stroke length, but it can be done from about 15,500 feet with rods stressed to 40,000 psi.

Present day tubing permits pumping from as deep as 16,000 feet if the casing size allows use of a properly tapered string. This is about 500 feet deeper than rods can operate; consequently, tubing strength is not a major limitation of rod pumping. When it is necessary to pump from below 11,500 feet, a tapered string, consisting of from two to three sizes of tubing should be used. A tapered string of 2½- and 2-inch at 14,500 feet, or of 3-, 2½- and 2-inch at 17,900 feet, has a safety factor of approximately 1.15 during a stripping job.

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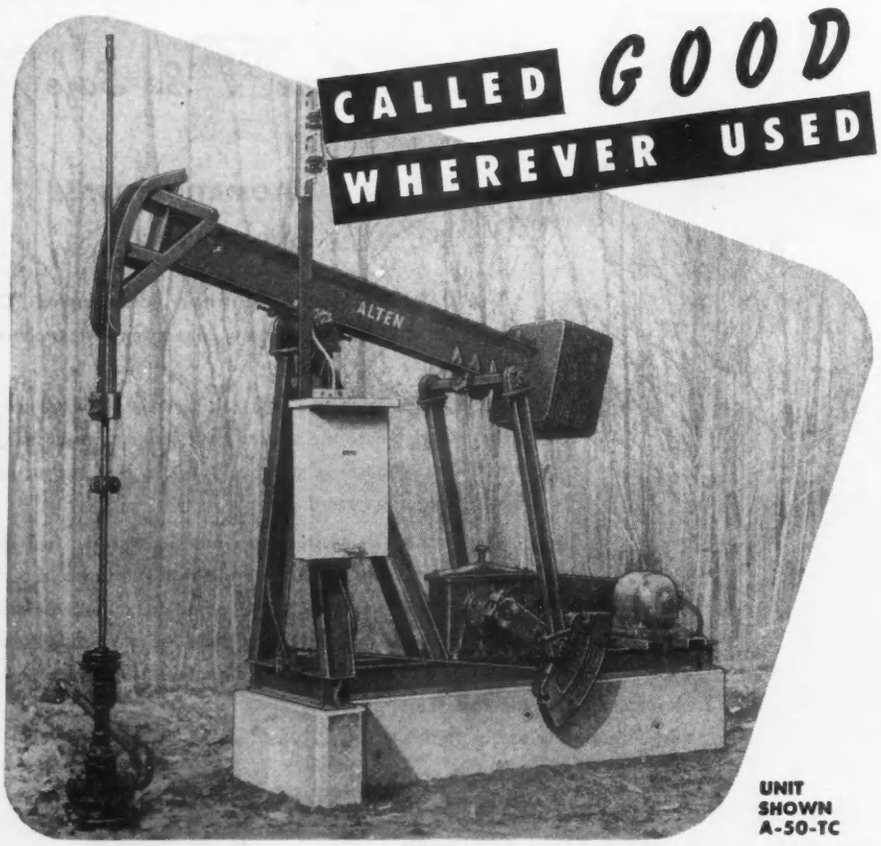

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Economics of Cycling

By MILAN G. ARTHUR, Union Oil Company of California, Whittier, Calif.

It is hazardous to make broad general conclusions regarding the economics of methods of gas injection. In black oil reservoirs it is usually profitable to maintain reservoir pressure at high values but in some cases where the reservoir permeabilities are extremely high, the economically recoverable oil may be greatest for cycling at rather low pressures. For a given condensate field it does not appear possible to determine the most profitable method of gas injection without careful consideration of many factors.

In pressure maintenance of black oil reservoirs, it has been determined that as reservoir pressure is reduced, the recovery to a given producing gas-oil ratio decreases to a minimum value and then increases rather sharply as pressure is further reduced. In reservoirs of comparatively low ratio of permeability to viscosity of reservoir oil, the rates of production in the pressure range below the minimum recovery pressure are unprofitable. In reservoirs of sufficiently high permeability-viscosity ratio to yield profitable production rates at low pressure, the profit from depletion followed by low pressure cycling may not be greater than the profit from high pressure cycling. In the cycling of condensate reservoirs, some of the factors to be considered include the increasing demand for gas, making it advisable to examine each field critically before deciding on the most desirable program.

Field Results of Jet Perforator Charges

By ROBERT HARCUS, Byron Jackson, Los Angeles.

The results obtained with lined shaped charges in penetrating steel, concrete and natural rock formations have placed a new tool at the disposal of the petroleum industry. The new tool is capable of overcoming many heretofore insurmountable obstacles. The benefits which may be expected to accrue to the oil industry are as follows: (1) increased production by (a) obtaining oil from previously non-productive reservoirs; (b) overcoming natural or man-made barriers blocking production; (c) increasing the effects of acidizing; and (d) improving the effectiveness of secondary recovery; (2) increased drilling rates in excessively hard formations; and (3) recovery of well pipe, thereby alleviating the steel shortage and making maximum use of existing casing.

Up to this time casing severing, opening of tight formations, and drilling of extremely hard formations have been on an experimental basis. However, casing severing and formation penetrating are

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In Rainbow Multiple V-Belts, all of the multiple pulling cords are concentrated in a balanced unit, called the Equa-Tensil Cord Section. This scientifically-designed unit allows each cord to pull its own share of the load, smoothly absorbs shocks and exerts tremendous tensile strength under heavy loads.

Pulling power is increased even more by straight sidewalls, which grip the grooves for complete contact the full height of the belt. Protective jackets increase the grip while keeping out dirt and prolonging wear.

Rainbow V-Belts have high operating economy because of their low-stretch characteristics. They are interchangeable with all other standard makes. Lengths are matched for multiple use. For complete information, write to Mechanical Goods Division, United States Rubber Company, Rockefeller Center, New York 20, N. Y.

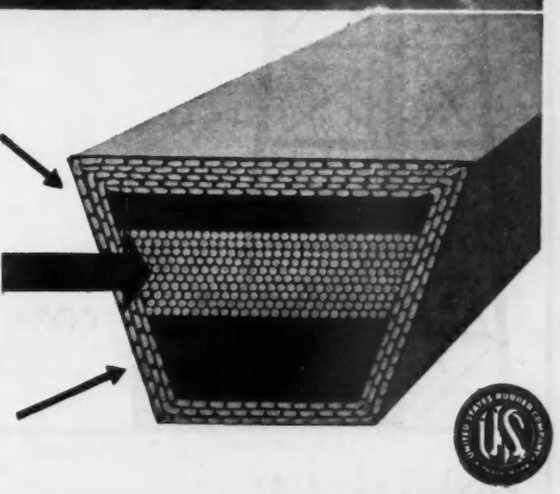
"U.S." RAINBOW MULTIPLE V-BELTS

WITH THE EQUA-TENSIL CORD SECTION

Top section that completes a closely engineered balance with the lower part, for efficient placement of Equa-Tensil power unit. Remains cool under constant stretch and turn.

Equa-Tensil cord section—all cords scientifically placed, each pulling its share of the load.

Foundation member—a sturdy level cushion for the Equa-Tensil section. Provides structural firmness for V-grooves and also over the flat pulley of V-to-flat drives.



US

expected to be undertaken on a commercial basis in the next two months.

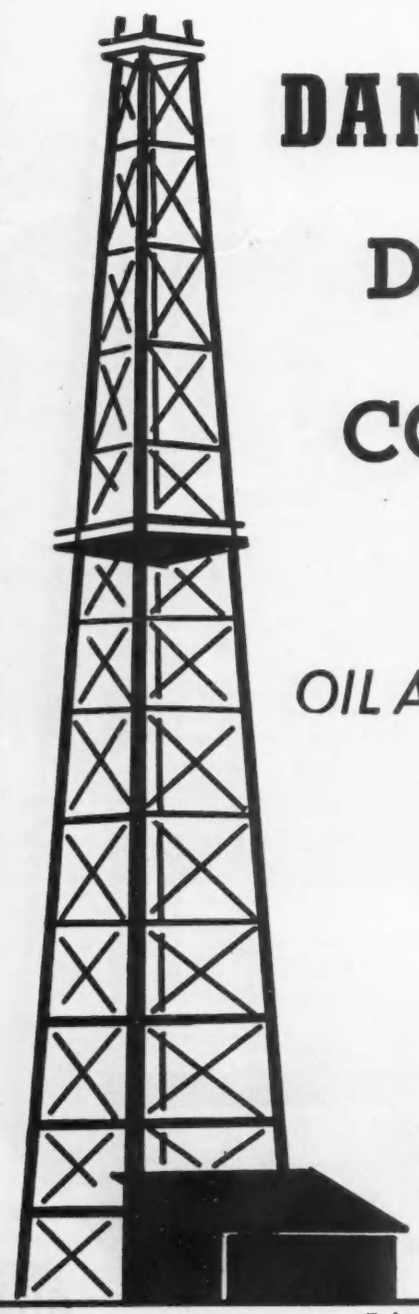
Recent Diamond Coring in California

By WILLIAM C. HARRINGTON, Standard Oil Company of California, Taft, California, and MAX C. EASTMAN, United States Navy, Taft, Calif.

Over 98 percent of the total footage cored with the use of diamond coring equipment in California has been in the Stevens Zone of Paloma, Coles Levee and Elk Hills oil fields. This zone varies from 5150 feet to 11,600 feet in depth and consists of sediments ranging from hard cherty shales and sandstones to soft shales and loosely consolidated sands. Both fractured and massive shales occur. In the oil bearing sands of the Stevens Zone core recovery approaches 100 percent; it is $8 per foot cheaper than rock bit drilling and $24 per foot cheaper than rock head coring. As the sands grade into shales the economic advantage of the diamond equipment decreases to the point where it is more expensive than rock drilling, but still cheaper than rock coring. Evidence is presented to show that diamond equipment gives very poor performance in soft shales and has cut slower than rock core heads in soft sands. The shales, especially when fractured, tend to jam in the core barrels, reducing the number of feet per trip.

Attempts to core formations other than the Stevens have not been sufficiently sustained to provide conclusive data. Some attempts to core hard schists and basalts failed, presumably due to the partially fractured nature of the rock cored. The necessity of low rates of circulation imposes some mechanical limitations on the use of the equipment.

DAN L. CLARK W. M. AVERILL RUPERT COX



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Progress of API Standards

By HALLAN N. MARSH, General Petroleum Corporation, Los Angeles, Calif.

The old expression, "standardization is stagnation," does not apply to the oil industry. Progress of the industry is continually being aided and indicated by the progress of its standard specifications. Today there are 29 standards on drilling and production equipment, sponsored by 11 main committees under the guidance of the Central Committee on Standardization. The first standard of the API division of production was adopted in 1924.

As the need for certain specifications is outgrown, they are rescinded. This is shown by the fact that the major specifications are on the average about 20 years old, but have run through a total of 183 editions, an average of about six each. The very important Pipe Specification is in its fourteenth edition with two subsequent supplements. Nine specifications have editions dated 1947, and 13 others have 1947 supplements, leaving only seven specifications more than a year old, as shown by appended list which the author presents with his paper.

API standards tend to accomplish the following purposes: (1) interchangeability; (2) economy, (3) utility, and (4) understanding. The API monogram, registered in the U. S. Patent Office, is available to manufacturers providing they conform with pertinent specifications. API specifications may cover any or all of the following features: (1) dimensions, (2) method of manufacture, (3) physical properties of material, (4) chemical properties of material, (5) performance ratings of finished product, (6) gaging practice, and (7) nomenclature.

Application of Secondary Recovery In the United States as Related to Emergency Oil Requirements

By PAUL D. TORREY, Consulting Engineer, Houston.

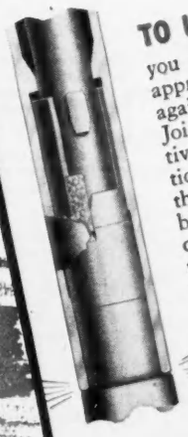
Competent authorities have presented evidence that the immediate future ordinary demand for oil can be met, but there is serious question whether existing primary reserves are adequate to supply a prolonged emergency demand. Since the development of new production from prospects in the Tidelands is being retarded by federal action, the most promising approach to the problem of supplying oil for national defense may be found in the more general application of methods for increasing the recovery of oil from known reserves. The reserves of oil which will not be

NEW The SHAFFER-WAGGENER BUMPER SAFETY JOINT

Jars automatically-and repeatedly!

Foolproof release whenever desired!

Here's something completely new that has already proven itself on one deep well after another—the Shaffer-Waggener Bumper Safety Joint. It combines in one tool the two most effective methods of protecting against stuck pipe . . . a rigid, wobble-free drive down Bumper Sub that can be run in the drill string for jarring through formation bridges, tight spots, and freeing "balled-up" bits or driving out of key seats when coming out of the hole—plus a foolproof Safety Joint that assures quick release from drill collars that have become hopelessly stuck. What's more, as a Bumper Sub it operates *automatically* . . . and as a Safety Joint it is the *strongest*—not the weakest—joint in the string. *There's nothing else like it for all-around safety and dependability!*



TO USE AS A BUMPER SUB

you need only slack the weight of approximately 2000 ft. of drill string against the top of the Bumper Safety Joint. This weight actuates a positive trip mechanism which automatically releases, allows the weight of the pipe to strike a sharp downward blow, and then the tool automatically resets itself for another blow as the pipe is raised. Blows can be struck repeatedly and continuously by simply raising and lowering the drill string, thus permitting prolonged jarring as long as necessary to free the string.

TO USE AS A SAFETY JOINT

for quick, positive release from stuck drill collars in the event they cannot be loosened, you simply slack the weight of the string to trip the Bumper Safety Joint and then apply left torque and slightly raise the tool to release. The slight reverse torque rotates the drive keys into an unlocking slot similar to a "J" tool. Then, by simply lifting the string, complete release from the stuck portion of the drill string is effected. The mandrel remaining in the hole is of smaller diameter than the drill collars, thus facilitating fishing operations in tight holes.

Advantages as a BUMPER SUB

- The Shaffer-Waggener Bumper Safety Joint remains in locked position at all times until the required tripping weight is placed on it. Therefore, there is no "working" of the joint during normal drilling operations—hence, no wear on the tool, its packing or parts.
- The Bumper Safety Joint is an *automatic* Bumper Sub—it jars automatically, and re-sets automatically by simply raising and lowering the drill string. No complicated drill string manipulations are necessary.
- When pipe becomes stuck, the definite tripping action of the Bumper Safety Joint gives positive indication as to whether the string is stuck above or below the tool, thus saving vital time in proceeding with recovery operations.

Advantages as a SAFETY JOINT

- Because of its unique and positive releasing design, which does not require back torque, the Bumper Safety Joint is the *strongest* joint in the string—not the weakest, as in all other conventional Safety Joints. Therefore, it is equally efficient for *both* right and left rotation during all drilling operations.
- Complete release from stuck portion of drill string is effected *only* by tripping the tool and then applying reverse torque combined with upward movement. There is no danger of the tool releasing during jarring or drilling operations!
- The Shaffer-Waggener Bumper Safety Joint is packed with chevron-type asbestos packing adequate to withstand any known bottom hole temperature—and adequate to insure leakproof operation under continuous high circulation pressures.

AVAILABLE IN ALL SIZES...

The Shaffer-Waggener Bumper Safety Joint is available in a wide range of sizes for use with all commonly-used drill strings. In each size the amount of weight necessary to operate the tool equals approximately the weight of 2000 ft. of the corresponding size of drill pipe.

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
EXPORT SALES OFFICE: Shaffer Tool Works, 30 Rockefeller Plaza, New York, N. Y., U. S. A.

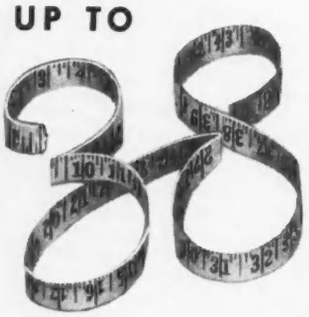
recovered by present production methods are tremendous. For example, the oil which will remain in permeable Permian reservoirs of West Texas alone, and which should be susceptible to improved recovery technology, is sufficient to supply the maximum estimated demand for national defense for a period of about six years, if it could be made available at the desired rate.

There is undoubtedly some point where secondary recovery operations in deep fields and in thin reservoirs will not be profitable because of competition from synthetic and substitute fuels. Production of liquid fuels from natural gas already is an accomplished reality. Competition from synthetic fuels produced from coal and from oil manufactured from shale is more remote, and has little bearing on the profitable application of secondary methods in most fields where promising additional recovery possibilities exist. The results obtained from the application of secondary methods in various parts of the country can be utilized impressively in arguments against federal control for unique reasons. These methods have been developed by and for the industry, and their application can always be cited as direct recognition of the responsibility to assure the maximum economic recovery of oil. Efficient primary oil recovery many times is taken for granted, and is regarded merely as an example of good business, whereas the oil produced by secondary methods carries with it the special significance of salvaging a valuable resource which might otherwise be irretrievably lost.

SPECIALS ?

...SURE!...

ANY SIZE YOU WANT UP TO



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Aetna ball thrust bearings are available in all standard types and sizes; special sizes up to 38 inches O.D. Write for new catalog and name of nearest Aetna field engineer.

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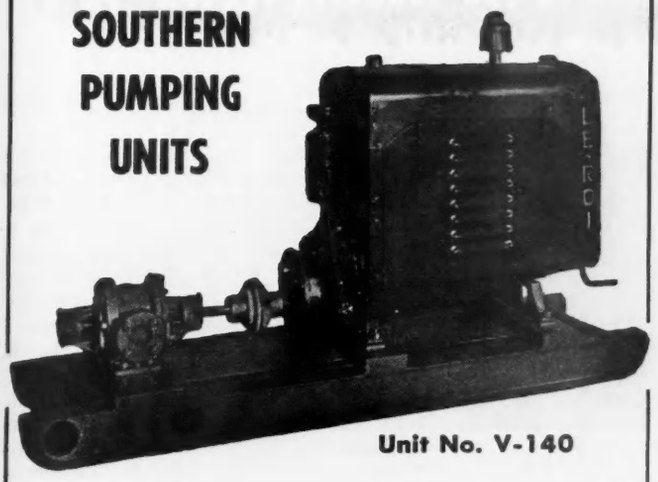
THE OIL MAN'S CALENDAR

JUNE 2–4	Southern Gas Association, Annual Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas.
3–5	National Oil Scouts & Landmen's Association, Annual Convention, Denver.
3–5	National Oil and Gas Association, Annual Convention, Dallas.
6–8	Petroleum Equipment Suppliers Association, Colorado Springs, Colo., Broadmoor Hotel.
17–18	Kentucky Oil and Gas Association, Lexington, Kentucky, Hotel Lafayette and Phoenix Hotel.
JUNE 30 July 2	American Petroleum Institute, Eastern District Meeting, White Sulphur Springs, W. Va., Greenbrier Hotel.
JUNE 30 July 3	Canadian Gas Association, Annual Convention, Jasper, Alberta, Jasper Park Lodge.
SEPT. 14–16	Pacific Coast Gas Association, Annual Convention, Santa Cruz, Calif., Hotel Casa del Rey.
16–18	National Petroleum Association, Atlantic City, N.J., Hotel Traymore.
27–28	Independent Petroleum Association of America, Annual Meeting, San Antonio, Plaza Hotel.
OCT. 4–6	American Institute of Mining & Metallurgical Engineers, Petroleum Division, Fall Meeting, Dallas, Adolphus Hotel.
4–9	American Association of Petroleum Geologists, Midyear Meeting, Pittsburgh, Pa.
4–9	American Gas Association, Annual Convention, Technical Section, Atlantic City, Ambassador Hotel.
11–13	American Association of Oilwell Drilling Contractors, Annual Meeting, Houston, Rice Hotel.
14–15	Indiana Independent Petroleum Association, Fall Convention, Indianapolis, Ind., Hotel Severin.
14–15	Texas Mid-Continent Oil and Gas Association, Annual Meeting, Fort Worth.
14–15	American Institute of Mining & Metallurgical Engineers, Petroleum Division, Fall Meeting, Los Angeles, Elks' Club.
NOV. 8–11	American Petroleum Institute, Annual Meeting, Chicago, Stevens Hotel.
15–18	American Oil Chemists' Society, Fall Meeting and Technical Sessions, New York, Pennsylvania Hotel.
MAR., 1949 24–25	New England Gas Association, Boston, Hotel Statler.

Nomads Chapter monthly meetings: **Los Angeles**, second Wednesday, Jonathan Club, B. M. Landis, Secretary. **Houston**, second Monday, Houston Club, Harry E. Estes, Secretary, Telephone Charter 4-7611. **Dallas**, L. A. Little, Secretary, Telephone Justin 8-1726. **Tulsa**, third Wednesday, Hotel Tulsa, Anthony Gibbon, Secretary, Telephone 3-1844. **New York**, first Monday, Louis Sherry's, Norris Boulden, Secretary, Telephone WIckersham 2-1311, extension 260.

SOUTHERN PUMPING UNITS



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Le Roi Power Unit — Viking Pump Capacity 140 barrels per hour.

Complete units and replacements in Houston and Kilgore stocks.

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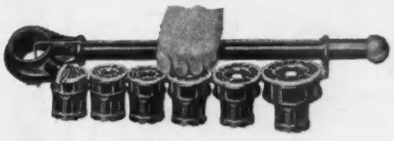
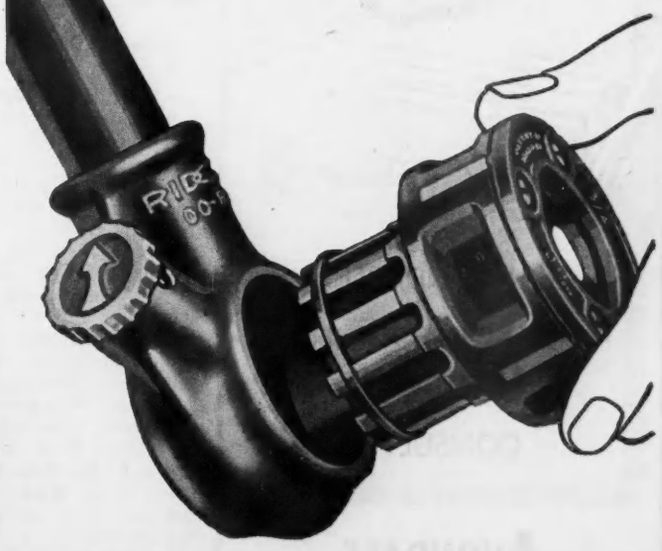
OOR Ratchet Threaders are fast and efficient on 1/8" to 2" pipe

● Just snap in size die head you need and you're ready to cut perfect threads on 1/8" to 2" pipe. Dies snap into ratchet ring from either side—can't fall out. You don't need special dies for close-to-wall threads. Tough steel-and-malleable construction—long life heat-treated tool-steel dies. No. 00R, 1/8" to 1" pipe; No. 111R, 1/8" to 1¼"; No. 12R, 1/8" to 2." Buy these durable threaders at your Supply House.



Free handy carrier for any group of sizes.



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The Igloo WATER COOLER

"the truly Convertible Cooler"

This cooler is corrugated for greater strength and durability being of all welded construction. It is fully insulated with granulated cork to keep water colder longer. Added features include, conversion from spigot to non-spigot type, no solder joints to break out and a reinforced innerbottom.

Igloo Water Coolers and Spigots Are Available at All Supply Stores

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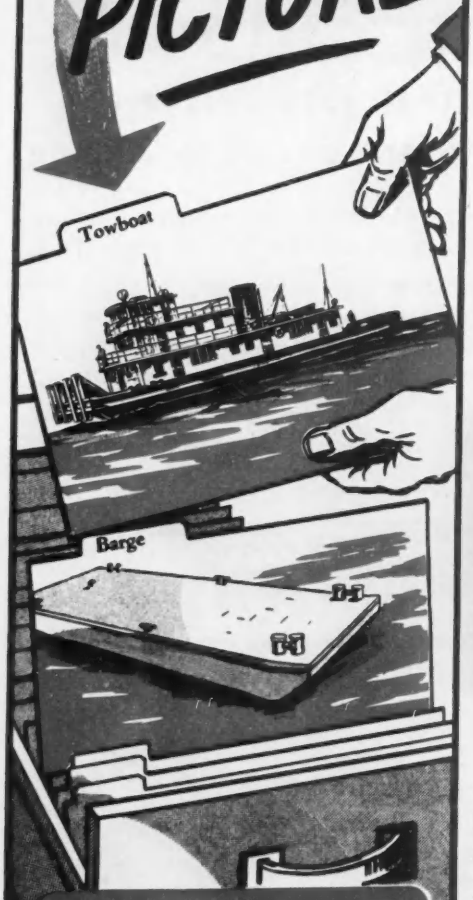

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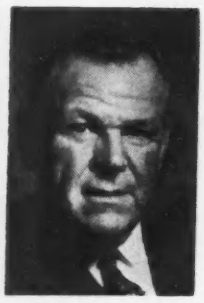
Men in the Industry NEWS



Harry C. Wiess

Hines Baker

Harry C. Wiess, president of the Humble Oil & Refining Company since 1937, has been elected chairman of the board, and **Hines H. Baker,** executive vice president since 1945, was elected president. **Morgan J. Davis** and **C. E. Reistle, Jr.,** were elected as new members of the board of directors and **L. T. Barrow, David Frame, D. B. Harris, J. A. Neath, Rex G. Baker,** and **H. W. Ferguson** were reelected to their positions as members of the board. Other officers elected

Morgan J. Davis

C. E. Reistle, Jr.

are **L. T. Barrow,** vice president; **David Frame,** vice president; **D. B. Harris,** vice president and treasurer; **J. A. Neath,** vice president; **Rex G. Baker,** general counsel; **H. K. Arnold,** secretary and assistant treasurer; **R. E. Seagler,** general attorney; **Gay Carroll,** comptroller; **J. R. Mulvey,** assistant comptroller; **Fladger F. Tannery,** assistant comptroller; **Paul Millsapps,** assistant secretary and assistant treasurer; **B. P. Barrett, Jr.,** assistant secretary and assistant treasurer; **M. B. Fox,** assistant secretary; **Dorothy A. Ratliff,** assistant secretary; **Margaret W. Hatch,** assistant secretary; **Charles E. Kugler,** assistant secretary; **O. F. Carroll,** assistant treasurer; **I. D. Breedlove,** assistant treasurer; **R. C. Huder,** cashier; **T. C. Brunson,** assistant cashier; **O. E. Roesler,** assistant cashier, and **L. W. Groce,** assistant cashier.

»

R. L. Bosworth, formerly vice president and treasurer of Continental Oil Company, has been elected financial vice president. **E. F. Battson,** formerly assistant to the president, has also been made a vice president, with headquarters in New York City. **Serge B. Jurebev,** formerly secretary, assistant treasurer, and New York office manager, was elected secretary and treasurer, and **E. J. Sheldon,** director of the service division at Ponca City, was elected assistant treasurer. **Thomas F. Dowd, Jr.,** formerly assistant treasurer, is the new controller, and **G. T. Bodman,** formerly general auditor, is assistant controller. **L. E.** Teverbaugh, former supervisor of internal auditors, will succeed Bodman. Other officers reelected were **F. L. McCollum,** president; **J. J. Cosgrove,** chairman of the board; **W. H. Ferguson,** executive vice president; **Harry J. Kennedy,** vice president, marketing; **W. C. MacMillan,** vice president, production; **Harold G. Osborn,** vice president, manufacturing; and **Charles A. Perlitz, Jr.,** vice president.

»

Clyde T. Foster, vice president of The Standard Oil Company (Ohio), has been elected executive vice president of the company. Foster joined Standard in 1929 as assistant manager of service stations. In 1931 he was made manager of service stations, and in 1935, head of the operating department of the sales department, taking over the following year the direction of all sales research work. In 1942 he became assistant to the president, and in 1943 he was made, in addition, manager of the industrial relations department. In 1946 he was elected vice president and a director of the company.

Clyde T. Foster

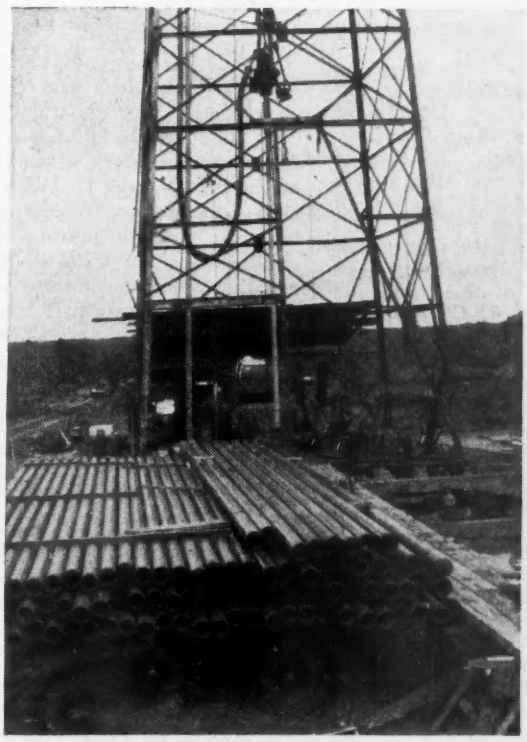
It's New... Check It!

PIPE GRINDING MACHINE designed and built to give pipe line contractors maximum service in polishing the bevel on plain end pipe in preparation for welding. The machine can be placed on pipe easily and quickly, and will clean the bevel on 24-inch pipe in 15 seconds, whereas a man with file would have to work at least 15 minutes. The grinder is constructed for durability, light weight, effectiveness and economy. Electrically driven, it may be operated from electric welding machines on the line.

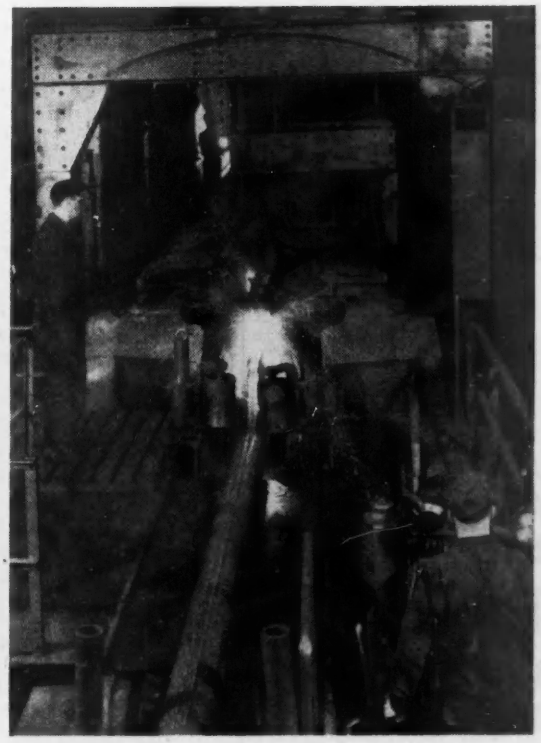
The Machine was perfected, and now being manufactured by

WICHITA TOOL REPAIR CO.
of Wichita Falls, Texas
Under license from O. R. Hall, inventor.

Dependability THROUGH Research



IN A TEXAS FIELD: running 4300 feet of 7-inch S-80 SMITHway Casing.



IN THE A. O. SMITH PIPE MILL: this automatic flash-welding machine, developed by A.O. Smith research, simultaneously welds SMITHway Casing along its full length.

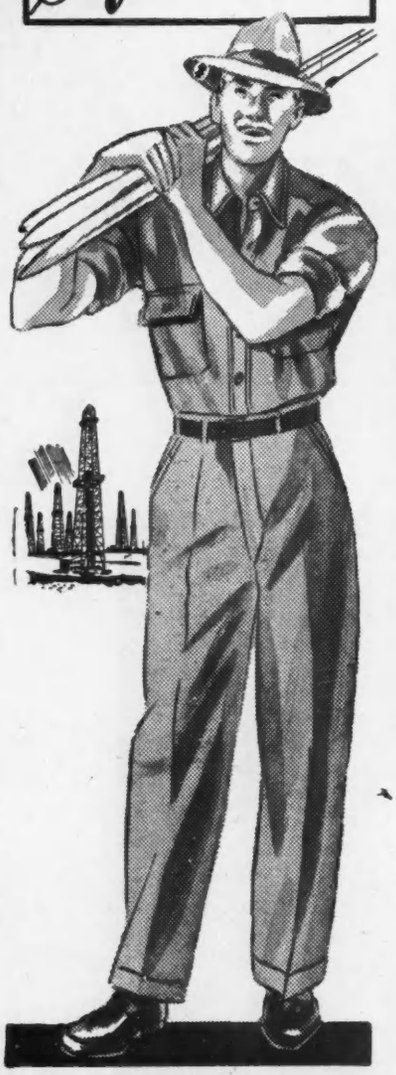
SMITH*way* CASING · LINE PIPE

A. O. SMITH CORPORATION

New York 17 • Pittsburgh 19 • Atlanta 3 • Chicago 4 • Tulsa 3 • Dallas 1
Houston 2 • Seattle 1 • Los Angeles 14 • International Division: Milwaukee 1

CARL POOL

Safti-flight



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A COMFORTABLE FIT

Be smart with your money—buy and wear these smartly styled color-matched work clothes on the job or into town. Fast dyed, preshrunk fabrics in the popular suntan and mauve shades. Shirts in half sizes 14 to 17; Pants 28 to 44 waist.

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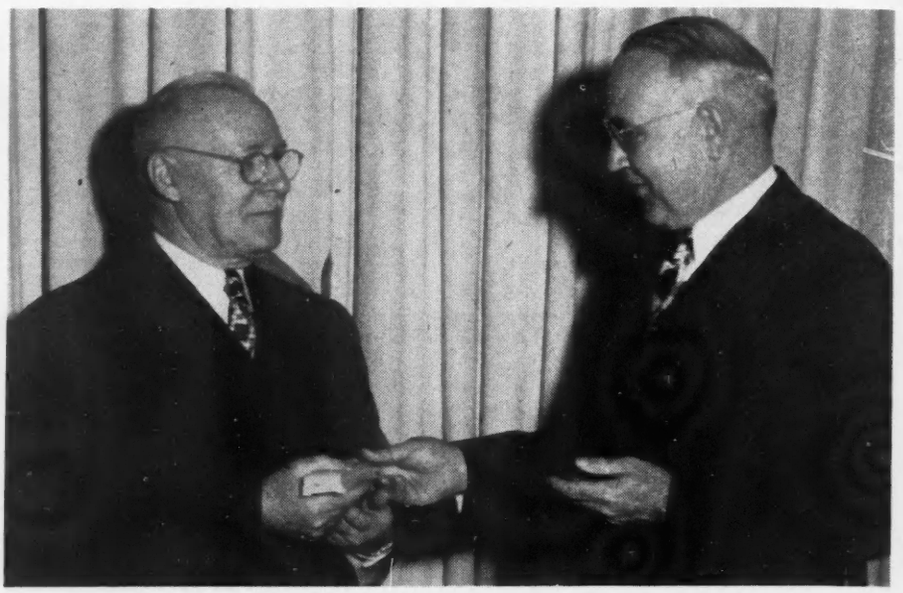
MEN IN THE INDUSTRY NEWS



Carl T. Newcomb (left), manager of operations for the Richmond Petroleum Company of California, receives a gold watch from R. C. Stoner, chairman of the board of Richmond and vice president and director of Standard Oil Company of California, on the occasion of his 36th year of service. Eight other employes with long service records also were honored at recent banquet ceremonies.

D. L. Wolfe has been promoted from manager of the coordinating department of Stanolind Oil Purchasing Company to manager of the Executive department with general direction over the newly formed trade and exchange section of the Executive department, the Field Operations department, and the Coordinating department. **Pat M. Broach** has been promoted to manager of the trade and exchange section with **J. C. Mytinger** and **H. A. Weatherby** as assistant managers. **J. T. Perkins** has been promoted to manager of the Field Operations department with **D. R. Ryan** and **R. G. Bandy** as assistant managers, and **W. A. Kirkpatrick** has been made assistant manager of the Coordinating department.

»

James T. (Jim) Rasbury, formerly director of industrial relations for Western Petroleum Refiners Association, has been named head of a new department of industrial relations for Sunray Oil Corporation. He will coordinate employe industrial relations activity for the company throughout all production and refining divisions.

»

Roy M. Smith, who has been division manager for Cimarron Petroleum Company for the past ten years, has been elected president of the company, succeeding the late **Robert Bowles.** Cimarron has production in Texas, Oklahoma, Louisiana, and California. While the home office has always been in Houston, Smith will continue his residence at Norman, Okla.

»

Frank T. Page has been appointed manager of Phillips Petroleum Company's crude oil purchasing and sales division office in the Philtower Building, Tulsa. Page is a graduate of the University of Illinois and a former captain in the U. S. Army Air Corps.

Rex V. Phelps has been appointed manager of the Warren Maritime Corporation. The promotion follows his supervision of engineering and other details of the S.S. Natalie O. Warren, first tank ship designed to transport LPG products. He will continue to serve as chief engineer for the LPG division of Warren Petroleum Corporation of which the maritime corporation is a wholly-owned subsidiary.

»

Frank Wallace, for 20 years drilling superintendent of H. F. Wilcox Oil and Gas Company, Tulsa, has been elected vice president in charge of drilling operations of Woods Drilling Company, New Orleans.

Coming

NEXT MONTH

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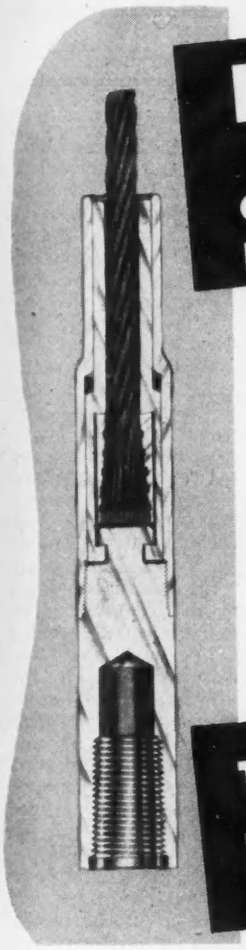
WORLD OIL*

ATLAS

•

Watch for it along with your July issue of WORLD OIL

**Established 1916 as The Oil Weekly*



IT'S NEW
THE CAVINS QUICK-CHANGE ROPE SOCKET

is a swivel type construction and is assembled to sand line tools, or taken off in less than a minute's time. Line waste and time loss due to frequent babbitting jobs are eliminated. The Thimble, which is permanently babbitted to the line, fits all sizes of Cavins Quick-Change Rope Sockets from the 1¾" OD to the 2¾" OD Sizes incl. The thimble is also small enough to pass through closely grouped or guarded sheaves.

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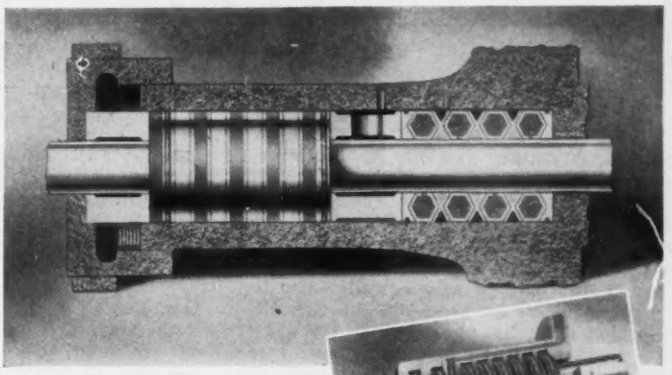
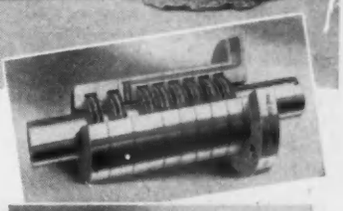
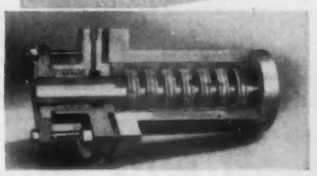


Above: GARLOCK 800 Vari-temp Ammonia Packing

Right: GARLOCK 875 Gas Compressor Metal Packing





GARLOCK 835 Refrigeration Compressor Metal Packing

GP

Great Precision!

Great precision marks every step in the production of Garlock Metal Packings. These products are carefully designed by skilled Garlock engineers; they are precision-machined by skilled Garlock mechanics; they are made from metals produced to Garlock specifications.

Their superior performance and long life on many thousands of applications, therefore, is no accident. It is the natural result of the accuracy, the precision and the know-how entering into the production of every set of these packings. So whatever your metal packing requirements may be, Garlock can serve you to your satisfaction. Ask the Garlock representative or write for catalog.

THE GARLOCK PACKING COMPANY
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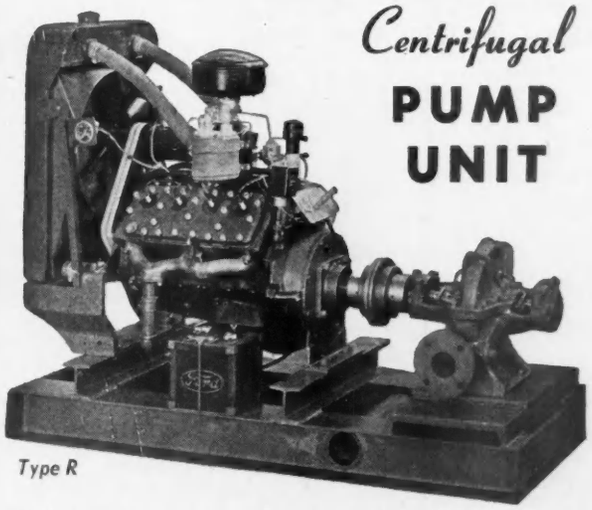
Centrifugal PUMP UNIT



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FOR high efficiency, dependability and low maintenance cost, you can't buy a better pump than a Worthington. Lockett Dealers—from warehouses located at, or near, the principal oil fields of Texas and Louisiana, backed by a large replenishing stock at our Houston and New Orleans Warehouses—can supply Worthington Pumps to meet every pumping need; also, *genuine* Worthington Repair Parts.

Worthington Pumps are adaptable for use with engines or motors of any specified type or manufacture, to provide a complete pumping unit.

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NEW ORLEANS HOUSTON DALLAS

T. A. Atkinson and **E. R. Paul** were named manager and assistant to the manager, respectively, in the Industrial Relations department of General Petroleum Corporation. Atkinson, lately assistant manager of industrial relations, joined the firm as a well puller and has occupied various positions in the Production department. Paul has for nearly 20 years been assistant manager of the Personnel department. He joined the firm as an assistant chemist in 1924 and has advanced through various field positions.

Dwight T. Colby has been named assistant general manager and manager of marketing, and **Frederick M. Neall** has been made manager of advertising, sales promotion and sales research for The Atlantic Refining Company.

»

George H. Roth, for the past 13 years with Shell Oil Company, Incorporated, as geologist, and more recently senior geologist at the company's Bakersfield Division, has joined **Wm. Ross Cabeen,** consulting petroleum engineers and geologists, Los Angeles, California.

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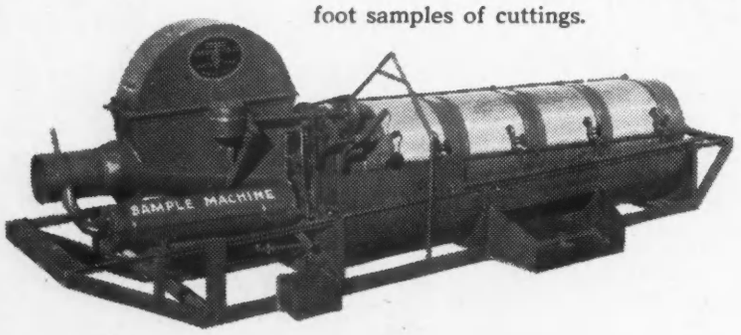

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Rear Admiral Thomas E. Boyce, USN (Ret.), has been appointed marine superintendent for Stanolind Oil & Gas Company and will have headquarters in the Houston division office, where he will work under the direction of **R. G. Bechtel,** division production superintendent. Boyce's appointment was announced along with the announcement that Stanolind has established a Marine department and will soon begin drilling at four offshore Gulf Coast locations. Boyce graduated from the Naval Academy in 1923 and served in the Navy until his retirement January 1. During the war he was executive officer of the cruiser Santa Fe in the Aleutians and Pacific and later commanded the attack transport President Polk. He holds the Silver Star and Legion of Merit and has 13 battle stars for Pacific area combat. **T. H. Jenkins,** senior mechanical engineer who served during the war as a commander in the Naval Reserve, will assist in marine operations. **Guy Johnston,** petroleum engineer in Stanolind's Houston office, will work with the contractor in the design and construction of the platforms for the wells.

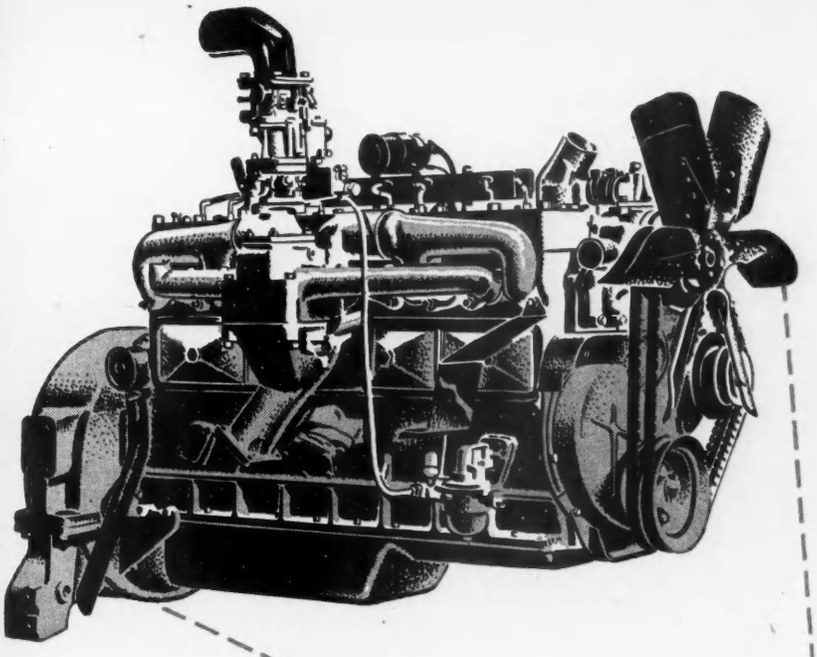
Thomas E. Boyce

»

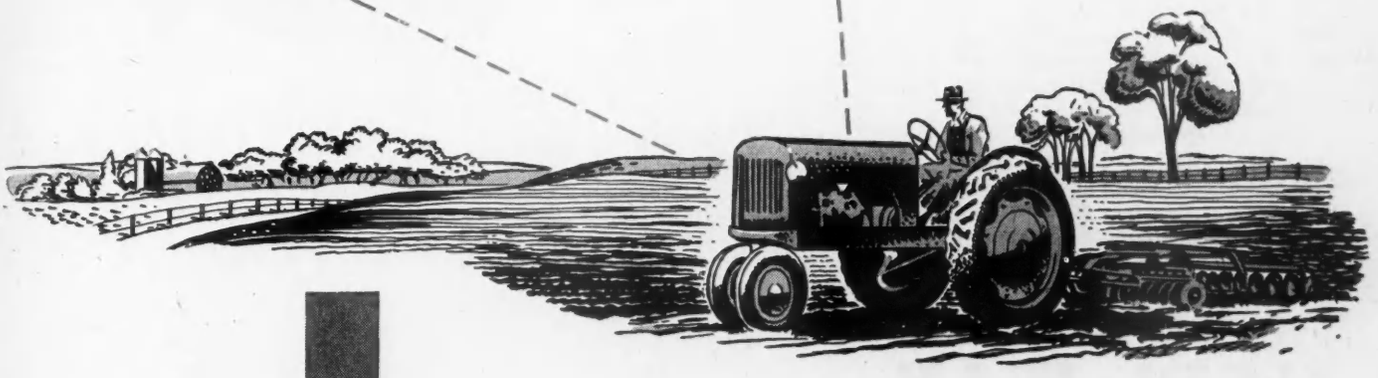
William A. Smith

Charles I. Thompson

William A. Smith, Houston, and **Charles I. Thompson,** Philadelphia, have been elected directors of Texas Eastern Transmission Corporation, owner and operator of the Big Inch pipe line system. Smith is president of the William A. Smith Construction Company and several other contracting and realty companies. He is also president of radio station KOHL and has extensive oil and cattle properties in Texas. Thompson is a partner in the law firm of Ballard, Spahr, Andrews & Ingersoll and a director of the Land Title Bank and Trust Company, Fidelity Mutual Life Insurance Company, and the Castle Shannon Coal Corporation. He was vice president and general counsel of War Emergency Pipe Lines, Inc., which constructed the Inch lines, and he has specialized in pipe line problems.



FOR A BETTER DAY'S WORK



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David D. Irwin

L. F. McCollum

L. F. McCollum, president of Continental Oil Company, and **David D. Irwin,** vice president in charge of transportation and supply of The Pure Oil Company, were elected to the board of directors of Great Lakes Pipe Line Company, succeeding **Dan Moran** and **C. B. Watson. Harry Moreland** was re-elected president of Great Lakes and **C. A. L. Walker,** who has been in charge of traffic since the products pile line company began operations, was added to the list of officers as vice president for traffic. Other officers reelected were **E. H. Skinner,** vice president for operations; **R. A. Kroenert,** secretary-treasurer; and **J. T. Robb,** assistant secretary-assistant treasurer.

Robert J. Beams has resigned from Shell Oil Company and has opened offices in the Leonhardt Building, Oklahoma City, as an independent geologist and petroleum engineer. Beams, who is secretary of the Oklahoma Chapter, AIME, graduated from the University of Oklahoma in 1941 with a B. S. in Geological Engineering. For the past seven years he has been employed by Shell as geologist and petroleum engineer in the Oklahoma, Kansas, North Texas and Illinois areas.

»

Don M. Mattocks has been elected secretary of Warren Petroleum Corporation and its subsidiaries, succeeding **John T. Oxley,** resigned. He joined the Warren organization in 1940 as an attorney and later was named assistant secretary. Since the acquisition of the Hanlon companies in 1946 he has been first assistant to **James E. Allison,** vice president and general counsel.

»

G. R. Brainard, Jr., has joined the Dallas staff of the Seaboard Oil Company of Delaware as assistant division superintendent of drilling and production. He was formerly a roustabout for The Ohio Oil Company, East Texas field, junior exploitation engineer for Shell Oil Company in Kilgore, Texas, and district superintendent for Shell Oil Company at Hobbs, N. M.

Frank H. Willibrand

R. W. French

R. W. French has been elected vice president in charge of production operations for Sohio Petroleum Company. Now headquartered at Oklahoma City as chief petroleum engineer and assistant to the president, French will go to the main offices of the parent company in Cleveland. Reporting to him from Oklahoma City will be **Frank H. Willibrand,** who was elected assistant vice president and manager of production operations for Sohio. Willibrand has been manager of the company's Mid-Continent division. **George S. Buchanan,** who has been assistant manager of land and exploration, was moved up by action of the Sohio board of directors to assistant vice president and manager of land and explorations, with headquarters in Houston. In his new capacity, he will report directly to **John P. Smoots,** vice president of the producing company. **H. D. Henderson** has been made assistant secretary and superintendent of the land department.

George S. Buchanan

»

W. C. MacMillan has been elected president of Texon Oil & Land Company, Group No. 1 Oil Corporation and Group No. 2 Oil Corporation. MacMillan is also vice president in charge of drilling and production for Continental Oil Company, which at a May meeting of stockholders, approved an agreement of merger of Texon, in which they now own approximately 89 percent of the stock. Simultaneous with MacMillan's election as president was the election of **E. J. Sheldon** to the board of directors of Texon Oil & Land Company. Other directors are **James J. Cosgrove, R. L. Bosworth, Charles A. Perlitz, Jr.,** and **P. L. Arrington.**

»

R. S. Miller, Rocky Mountain representative for Lufkin Foundry & Machine Company, was author of the article, "Comparisons and Ratings of Two-Cycle and Four-Cycle Spark Ignition Engines," which appeared on page 154 of the April issue of WORLD OIL. The byline denoting Miller as author of this article was unintentionally omitted.

NEW WAY
TO MOVE BIG DERRICKS
QUICKLY WITHOUT DISMANTLING

Near Odessa, Texas this derrick, weighing over 125 tons, was moved intact on Athey Forged-Trak Wheels—without disturbing the crown-block, traveling-block or draw works. The move was made at a speed of more than one mile per hour and the drilling contractor was able to start drilling three hours after the move was made.

In spite of the load and loose sand, the four pairs of Athey Forged-Trak Wheels supported the derrick on top of the sand, making it easy for the tractor to pull.

In Texas, derrick moving by this method is becoming the accepted practice, with moves up to 8 miles done in 2 days overall time compared with 10 days usually required by former methods.

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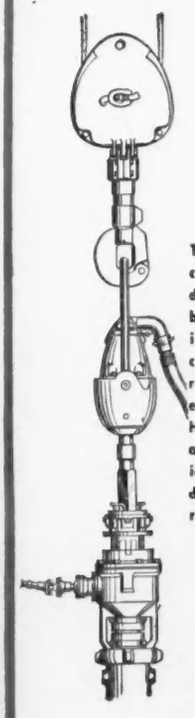
Your crew will have less down-time with this new swivel, because the full-floating washpipe rotates in two independent packing glands. The unique design of this packing arrangement literally cuts wear on the washpipe in half, because rotation is in either or both packings. Life of packing and washpipe is more than doubled, and when the assembly finally needs replacing it comes out easily without moving the gooseneck or hose. No special tools are required. Roller bearings are full-sized and heavy-duty, turning in a circulating oil bath. Extra-large fluid passage is built into the gooseneck, washpipe and spindle.



The new 45-Ton Swivel completes a unitized drilling string of Guiberson Tools for drilling, work-overs and clean-out work, using reverse circulation. The entire string of Block & Hook, Swivel, Kelly and Drilling Head is ideally suited for short derricks and portable rigs.

***See** the Guiberson representative for complete information on the New 45-Ton Swivel and the complete string.*

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G. F. McNair has been named manager of the Southwestern division of Central Pipe Line Company, with headquarters in Dallas. He was formerly manager of the crude oil department of Pan American Production Company in Houston. **Charles W. Scott,** supervisor of operations in the Southwestern Division and in charge of the Producing department of Allied Oil Company, Inc., has taken a leave of absence from active duty. **C. H. Marshall,** vice president of Allied Oil, will take over his duties and will supervise the operations of Central Pipe Line's Southwestern division. He has been in charge of the Tri-State Division of Central Pipe Line. **Leslie Paris** has been named general superintendent of operations of the Southwestern Division of Central Pipe Line Company. **H. C. Temple** is manager of operations and **F. C. Barclay** is in charge of crude oil purchasing department of the Tri-State Division.

»

Frank C. Love, Oklahoma City attorney, has joined Kerr-McGee Oil Industries, Inc., as vice president and director, and is to be assistant to **Dean A. McGee,** executive vice president. Love is a graduate of Oklahoma University and served for a time with Shell Oil Company, but in recent years he has been associated with the firm of Embry, Johnson, Crowe, Tolbert and Shelton.

Max R. Lents

Don R. Knowlton

Don R. Knowlton has been elected president and **Max R. Lents** has been chosen vice president and general manager of Old Ocean Oil Company and J. S. Abercrombie Company in Houston. Knowlton succeeds **Lloyd Noble,** former president, who is chairman of the board of the two companies. Lents takes over the position formerly held by **J. R. Butler,** who, together with **Martin Miller,** has formed the J. R. Butler Company, oil and gas consultants. Knowlton was formerly with Marland Oil Company of California and Phillips Petroleum Company. During the war he served as national director of production for PAW. In 1946 he formed a partnership with Frank Porter of the Fain-Porter Drilling Company in Oklahoma City and established the Knowlton Engineering Company, which he will continue to head. Lents was formerly employed by Shell Oil Company and the Cotton Valley Operators' Committee. He joined the Old Ocean Oil and J. S. Abercrombie Companies as assistant to the general manager in 1946 and has been in particular charge of production and plant operations in the Old Ocean field.

»

Dr. L. F. Athy, chief geophysicist for Continental Oil Company's Exploration division, has been promoted to manager of the Geophysical department at Ponca City, Okla. Other promotions to the Ponca City department include **Dr. J. A. Culbertson,** from division geologist at Houston to assistant manager of Geophysical department; **H. R. Prescott,** from assistant chief geophysicist to chief geophysicist; **D. D. Christner,** division geologist at Fort Worth to assistant chief geologist; and **C. L. Arnett,** from Kansas district geologist to district geologist. **W. Baxter Boyd,** district geologist at Ponca City, will succeed Christner as division geologist at Fort Worth, ologist. **W. Baxter Boyd,** district geologist at Shreveport, will succeed Dr. Culbertson as division geologist at Houston.

»

L. W. Gwin has sold his interest in the Schneider and Gwin Drilling Company and has organized the Gwin Drilling Company with headquarters at Percy, Ill.

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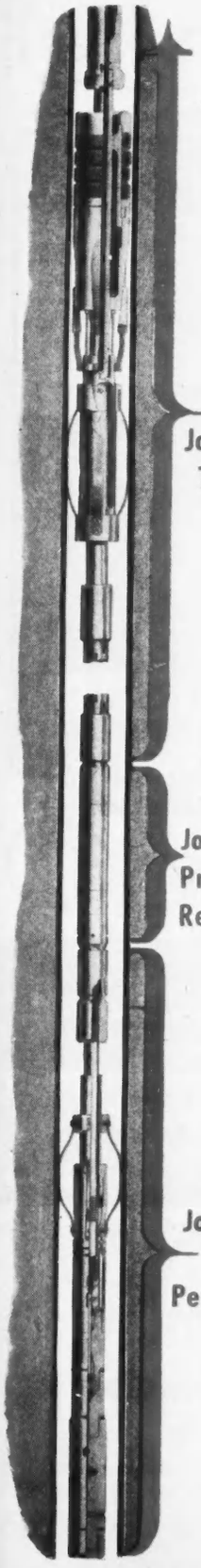


Important Notice

THE JOHNSTON FORMATION TESTER AND THE JOHNSTON GUN PERFORATOR ARE PATENTED TOOLS

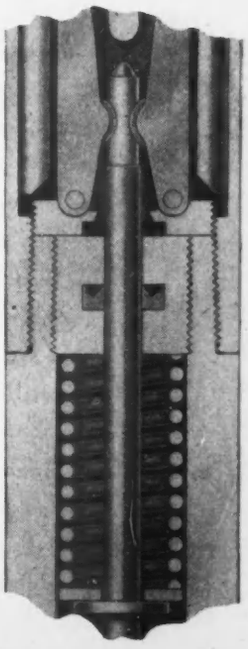
Here are some of the patents under which they operate:

The FORMATION TESTER

Formation Tester—Patent No. 2,073,107
Combination Formation and Testing Pressure Recorder, Patent No. 2,189,919
Main Valve—Patent No. 2,126,641
Equalizing Valve—Patent Nos. 2,129,216, 1,901,813
Pressure Recorder Mountings—Patent Nos. 2,161,233, 2,176,766
Adjustable Flow Bean—Patent Nos. 2,218,988, 2,186,488

The GUN PERFORATOR

Firing Head—Patent Nos. 2,307,360, 2,305,139, 2,295,634



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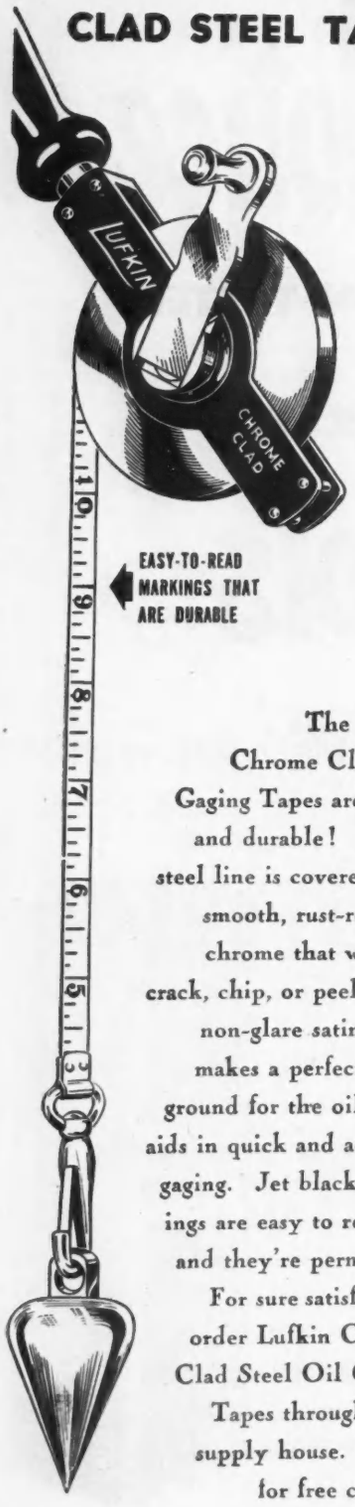

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MEN IN THE INDUSTRY NEWS

Transfers:

George A. Weaver, district geologist for The Pure Oil Company, has been transferred from Tyler to Corpus Christi, Texas . . . **V. V. Thomasson,** superintendent for Barnsdale Oil Company, from Marlow, Okla., to Shreveport . . . **Charles M. Tarr,** Continental Oil Company engineer, from Long Beach to Whittier, Calif. . . . **George A. Colling,** foreman for Standard Oil Company of California, from Newhall to Ventura, Calif. . . . **H. J. Stewart,** engineer, Sunray Oil Corporation, from Santa Maria, Calif., to Alice, Texas . . . **Norman A. Nelson,** engineer, Humble Oil & Refining Company, from Thompsons to Lolita, Texas. **Roy A. Baze,** engineer, from Jourdanton to Luling, Texas . . . **S. T. Walker, Jr.,** Phillips Petroleum Company engineer, from New London, Texas, to Berwick, La. . . . **J. Kenneth Myers,** engineer, Union Oil Company of California, from Torrance to Los Angeles . . . **P. C. Barbour,** foreman at Rosenberg for Gulf Research & Development Company, to Conroe, Texas . . . **W. A. McFadden,** geologist, Western Geophysical Company, from Rockdale to Houston . . . **G. W. Fetter,** White Deer foreman for Gulf Oil Corporation, to Dial, Texas . . . **L. C. Pursel,** superintendent for Scott Drilling Company, from Winters, Texas, to Elk City, Okla. . . . **S. H. Miley,** Bay City superintendent for Skelly Oil Company, to Refugio, Texas . . . **W. P. Lawrence,** foreman for Amerada Petroleum Corporation, from Big Lake to San Angelo, Texas . . . **Clyde E. Davis,** engineer for Gulf Oil Corporation, from Crane to Goldsmith, Texas . . . **H. E. White,** Houston superintendent for Shell Pipe Line Corporation, to Healdton, Okla. . . . **C. H. Thurber,** Plymouth Oil Company engineer, from Laredo to Post, Texas . . . **O. E. van Meter, Jr.,** engineer for Magnolia Petroleum Company, from Midland, Texas, to Houston . . . **Alvin E. Hall,** Phillips Petroleum Company engineer, from Odessa, Texas, to Pawhuska, Okla. . . . **M. H. Anderson,** engineer, Phillips Petroleum Company, Phillips to Pampa, Texas . . . **Peter F. Forness,** foreman for Stanolind Oil & Gas Company, to Wink, Texas . . . **Benjamin R. Luscomb,** engineer for Stanolind Oil & Gas Company, from Wink to Fort Worth . . . **W. R. Montague,** Sun Oil Company superintendent, from Lafayette, La., to Beaumont, Texas . . . **Howard R. Born,** geologist for Magnolia Petroleum Company, from Shreveport to Houston . . . **Edward G. Dobrick,** geologist for The California Company, from Lexington to Versailles, Ky. . . . **Roland F. Beers,** geologist, Geotechnical Corporation, from Boston, to Troy, N. Y. . . . **R. Bruce Miller,** engineer for the Ohio Oil Company, from Findlay, Ohio, to Port Arthur, Texas . . . **Robert E. Moyar,** engineer for International Petroleum Company, Ltd., from Rouseville, Pa., to Toronto, Ont., Canada . . . **J. J. August,** Casper foreman for General Petroleum Corporation, to Worland, Wyo. . . . **J. P. Ellis,** foreman for Mid-Continent Pipe Line Company, from Weleetka to Wewoka, Okla . . . **M. P. Moore** to Oklahoma City, **H. C. Steele** to Ardmore, Okla., and **J. R. Mason** to Wichita, Kansas, as crude oil buyers for Stanolind Oil Purchasing Company in Tulsa.

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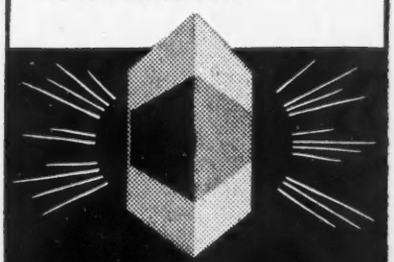

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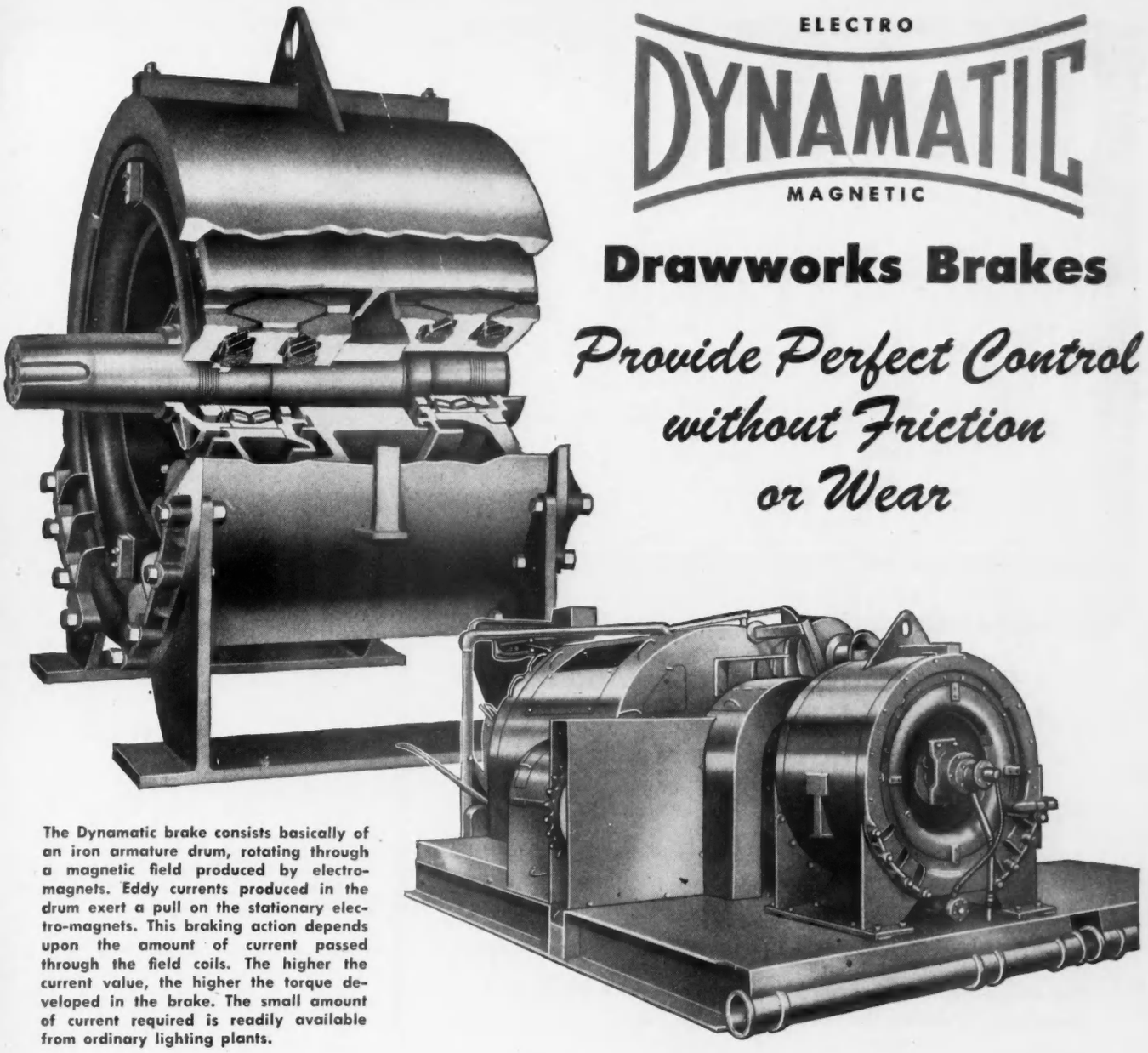
Provide Perfect Control without Friction or Wear



The Dynamatic brake consists basically of an iron armature drum, rotating through a magnetic field produced by electro-magnets. Eddy currents produced in the drum exert a pull on the stationary electro-magnets. This braking action depends upon the amount of current passed through the field coils. The higher the current value, the higher the torque developed in the brake. The small amount of current required is readily available from ordinary lighting plants.

THE Dynamatic electro-magnetic drawworks brake provides a braking effect which is variable and controllable through a range from 800 rpm to a drum speed slow enough to set slips on the heaviest strings of drill pipe or casing, without the assistance of the friction brake. Mounted similarly to the hydraulic type brake, the Dynamatic drawworks brake is comparable in size and weight. Energy absorbed by the brake is converted into heat, and dissipated in the cooling water. Remote control at the driller's position permits ease and speed of operation.

Outstanding characteristics of the Dynamatic brake are high torque at low speeds, and the complete absence of friction or wear, except on bearings, which have been designed oversize to permit continuous operation for years.

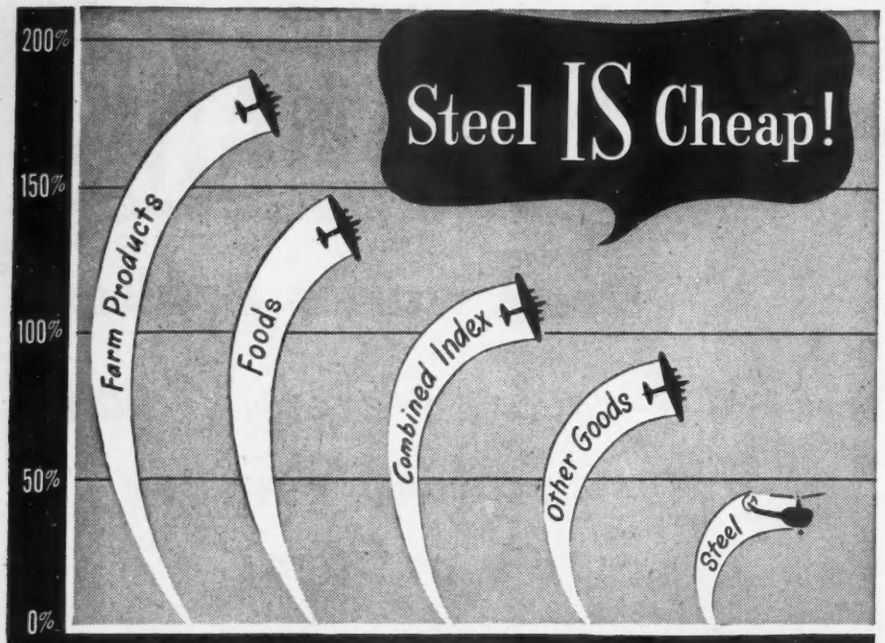
The Dynamatic brake is readily applied to practically all drilling rigs.

Sales Representatives: GRIBBIN AND BAYLOR Los Angeles • Houston • Fort Worth

DYNAMATIC **CORPORATION** • KENOSHA, WISCONSIN

Subsidiary of **EATON MANUFACTURING COMPANY** *Cleveland, Ohio*

General Offices: CLEVELAND, OHIO. *Plants:* CLEVELAND • MASSILLON • DETROIT • SAGINAW BATTLE CREEK • MARSHALL • VASSAR • KENOSHA • WINDSOR (CANADA)



NO ZOOM In Steel Price Rises!

U. S. Department of Commerce And Council of Economic Advisors Report Steel Price Increases Have Been Moderate

Recently the steel industry was again brought up to the whipping post.

After a terrific tongue lashing, the Government set in motion three investigations to determine whether more punishment should be administered.

The Department of Justice found no evidence of collusion.

The Department of Commerce reports steel price advances have been more moderate than in other lines.

The Council of Economic Advisors admits steel price increases have been less than those for manufactured articles, agricultural products, wages and material costs.

How moderate — how much less have been the increases in steel prices is shown in the chart above. It is based upon Government indexes of wholesale prices of various commodities as compared to steel mill products and shows the price increases from 1939 to February of 1948.

Comparison of steel prices to the prices of virtually any other components of the national income shows the irrefutable fact that the steel industry has held a taut line on steel prices and that the most wanted and most essential of metals — **Steel IS Cheap.**

SHEFFIELD STEEL CORPORATION

HOUSTON — Carbon and Alloy Steel, Ingots, Blooms, Billets, Plates, Sheets, Merchant Bars, Steel Joists, Structural Shapes, Road Guard, Reinforcing Bars

KANSAS CITY — Welded Wire Mesh, Wire Products, Wire Rods, Fence, Spring Wire, Nails, Rivets, Grinding Media, Forgings, Track Spikes, Bolt and Nut Products

TULSA

SHEFFIELD STEEL

SALES OFFICES: Chicago, Ill.; St. Louis, Mo.; Des Moines, Ia.; Omaha, Nebr.; Wichita, Kans.; Denver, Colo.; Oklahoma City, Okla.; Dallas, Tex.; San Antonio, Tex.; Lubbock, Tex.; New Orleans, La.; Shreveport, La.

DEATHS

J. G. Hamill, 79, drilling contractor, died in El Campo May 2 after a short illness. He was partner in the firm of Hamill & Hamill, which drilled the famous Spindletop gusher in 1901. **Colonel Anthony F. Lucas** contracted the firm to drill near Beaumont, where they brought in the gusher which blew Hamill's brother off the rig when it came in.

»

Joe Simmons, 60, retired independent oil operator, died at Refugio April 22. He became an independent operator in 1930 when the East Texas field was opened. Prior to this he superintended oil field operations for the Houston Oil Company at Haynesville, La., and later for Shell Oil Company in West Texas.

»

Concie Ross, 52, engineer for Humble Oil & Refining Company for 24 years, died at Houston April 14.

»

George W. Schweinhard, 58, a member of the oil and oil field supply industry for over 35 years, died in San Francisco on April 21. Schweinhard began his oil career with the old Kern Trading and Oil Company in 1912 and later entered the employ of Lucey Manufacturing Company at McKittrick, Calif. In 1922 he founded The Petroleum Equipment Company at Los Angeles which, under his guidance, became one of the larger independent oil field supply organizations in the state. When the company was purchased by Bethlehem Steel Company in 1945, Schweinhard continued as general manager until his retirement in 1947.

»

W. R. (Bill) Thawley, 56, chief scout for Gulf Oil Corporation, Tulsa, died April 24 of a heart attack. Thawley headed Gulf's scouting for 20 years, covering eight Western and Midwestern states and Canada. Prior to his affiliation with Gulf he was with the U. S. Department of Agriculture at Detroit. He was general chairman of the Nomenclature Committee of the Kansas-Oklahoma division of the Mid-Continent Oil and Gas association.

»

Eugene Loren Waldo, retired Mid-Continent oil man, and well-known artist, died April 22 in Ponca City, Okla., after an extended illness. Waldo was a boyhood friend of the late **Governor E. W. Marland** and was associated with him in oil enterprises, at one time being in charge of Marland's oil operations in Mexico. He went to Ponca City in 1926 to found with Marland the Southland Royalty Company, of which he was president until he retired from the business in 1928.

»

Allan E. Goodhue, vice president and director of Chicago Pneumatic Tool Company, died in New York April 20.

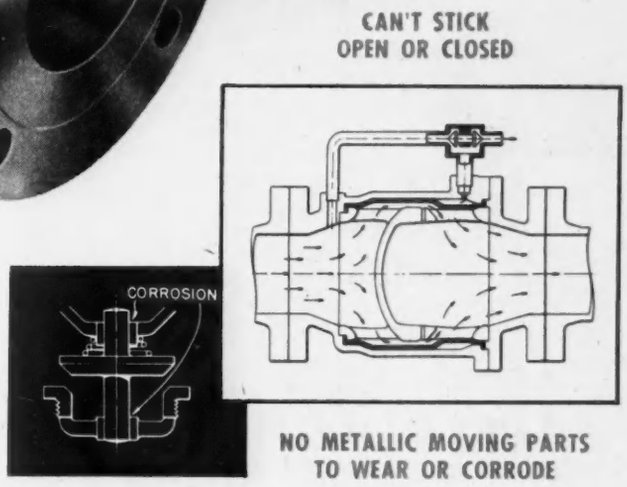
»

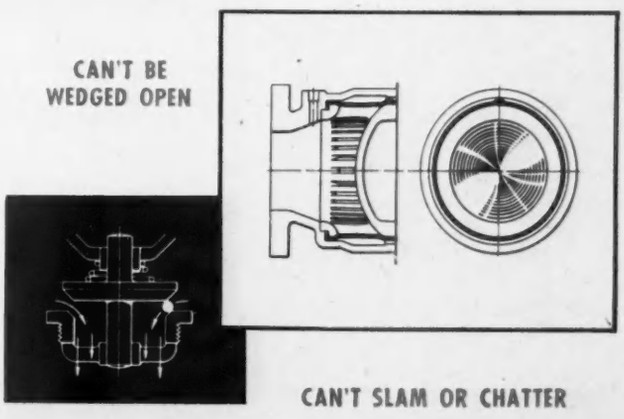
Graham D. Kendall, 40, geophysicist for Deep Rock Oil Corporation, died May 1, at a Tulsa hospital. Kendall had been with Deep Rock for about two years and prior to that time with Amerada Petroleum Corporation in seismograph work.

for AIR - GAS - OIL - WATER and SALTWATER at temperatures to 150°F

Grove Flexflo Valves are ideally suited for liquid and hydraulic fluid services, including flow control, pressure control, throttling, liquid level control, etc. Employing no metallic moving parts the Flexflo Valve is entirely free from mechanical friction, and hydraulic or mechanical shock. Based on thousands of installations Flexflo Valves will outlast any other type of valve on the market. Operation is accomplished by fluid pressure, controlled manually or automatically by means of an operating pilot. So simple and easy are all sizes of the Flexflo to operate, they require only a push of the finger, or a twist of the wrist. Many Flexflo valves, located at widely separated points can be centrally controlled from a single panel. Positive bubble-tight shut-off is assured at all times.

Get the new Flexflo Manual, illustrating important application data. Write today for Bulletin 800B.





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SIMPLICITY
ACCURACY
SAFETY

GROVE FLEX-FLO
Remote Control VALVES

GROVE REGULATOR COMPANY
6529 Hollis Street, Oakland 8, California

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Henry Paris Announces Purchase Of Hinderliter Tool Property

Henry Paris, president of Henry H. Paris Distributor, Inc., announced purchase of the Houston properties of the Hinderliter Tool Company, a division of the H. K. Porter Company, Inc. This property, located at 5104 Griggs Road, comprises 2½ acres and improvements.

Henry Paris

"We do not contemplate any immediate removal from our present location at 1125 Rothwell Street. Our business has been increasing steadily during the past several years, and this purchase was made to provide for expansion when necessary," Paris said. Hinderliter remains at the same location with its facilities under lease from the Paris organization.

F. D. Smith Appointed Manager Of Oilwell's Gulf Coast Division

F. D. Smith, Oil Well Supply Company general sales staff manager in the company's headquarters at Dallas, has been named manager of that U. S. Steel subsidiary's gulf coast division with headquarters at Houston.

A veteran of 20 years service with "Oilwell," Smith is a native of Marietta, Ohio, where he attended Marietta High school and Marietta College.

Joining the company in March, 1928, Smith served variously as storeman, field salesman and district manager in Kentucky and Tennessee until 1933 when he transferred to Oil City, Penn., with the eastern division sales department. In April, 1935, he was made district manager for Michigan and in January, 1941, he went to Mt. Vernon, Ill., as manager of the eastern division. He remained in that position until January, 1944, when he moved to headquarters in Dallas as assistant to general manager of sales and later assistant general manager of sales. He was appointed general sales staff manager January 1, 1948.

Wildman to Cover East Texas For Byron Jackson Company

Robert V. Wildman has been assigned to the Houston area by Byron Jackson Company to cover the East Texas Gulf Coast and East Texas operating territories and to work on export contracts.

Robert V. Wildman

Wildman, who has had varied experience as roughneck and supply salesman in California, joined Byron Jackson in 1947 and completed his shop and field training in March of this year.

Give Your Oil Well Drills A Hand With Fast Digging

YOU can eliminate costly drilling and production delays with fast-working Bucyrus-Erie ⅜- to 2½-yard excavators in digging slush pits, placing tools and equipment, preparing derrick sites, and handling the numerous other jobs on your location.

Effective application of power, proper weight distribution, remarkable balance of operating functions, and direct action control give Bucyrus-Erie excavators the "punch" that means high-output performance. These units match their speed with outstanding durability. Operators can maintain a fast, steady pace with minimum time for maintenance and repair.

Full convertibility insures versatility. Crane, dragline, clamshell, and shovel front ends are available for all machines; dragshovels up to ¾-yards.

Check with your distributor for more information.

118E47

BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN

SPEED

Speed is essential to oil field operations, and United helps speed your jobs by giving speedy delivery. No matter how large or small your order may be, when you need it—you need it quickly! You can count on United.

Uncle Sandy

THE UNITED SUPPLY MAN

Courtesy
Service
Dependability

UNITED SUPPLY
AND *Manufacturing* COMPANY
TULSA, OKLAHOMA
Stores in Kansas, Oklahoma, Texas,
Louisiana, and New Mexico

Hewitt Rubber Division Develops Hose for Liquid-Propane Gas

A hose which made it possible for the world's first liquid-propane gas tanker to operate in coastal service, carrying its cargo to the Eastern seaboard for use in thousands of industries, farms, and small town homes, has been developed by the Hewitt Rubber Division, Hewitt-Robins, Inc., of Buffalo, for the SS Natalie O. Warren, owned and operated by the Warren Maritime Corporation of Tulsa.

The exacting specifications establihsed by the Warren Company called for a hose that could withstand high working and test pressures. Because the liquid-propane gas requires special handling, a flexible, super hose was an absolute necessity for the successful operation of the new ship. When loading or unloading is completed, the hose must be drained under pressure. The new Hewitt hose has a bursting pressure of 1250 pounds.

Petroleum Sales Engineer Named By Detroit Diesel Engine Division

E. E. (Spike) Spicer has been appointed petroleum sales engineer for the Detroit Diesel Engine Division, General Motors Corporation. He will operate out of the company's petroleum industry sales office under the direction of Arch F. Campbell.

LESS COST PER FOOT with CHRISTENSEN CORE HEADS

The 1-2-3 of Christensen Core Heads

1—Fewer Round Trips

2—Faster Drilling

3—Greater Core Recovery

That's the proved performance of Christensen Diamond Core heads. In field after field, it's performance like this that adds up to LESS COST PER FOOT

Christensen engineers and manufactures Diamond Core Heads and Core Barrels. Competent field service.

See Our Listing In Composite Catalog

CHRISTENSEN DIAMOND PRODUCTS CO.

1975 South 2nd West • Phone 6-8738 • Salt Lake City, Utah

C. B. Miller Named Sales Manager Of Goodyear Division at Chicago

Charles B. Miller has been apointed district sales manager of Goodyear Tire & Rubber Company's Mechanical Goods division at Chicago. The district embraces Illinois, Wisconsin and Southern Indiana.

Charles B. Miller

Miller succeeds Guy E. McMahon, who will remain in Chicago as special representative for Goodyear industrial rubber products.

Miller has been with Goodyear since 1937, starting as a general line salesman in Florida. During the war he was employed by Goodyear Aircraft Corporation, and loaned to the government as a military products engineer. Since 1945 he has been Akron area field representative for the company's mechanical goods division.

Miller is succeeded in Akron by William F. Burdick, who has been with Goodyear since 1937.

John N. Martin Opens Tulsa Plant; Manufacture of Martin Cage Begins

John N. Martin, manufacturer, has just completed a modern plant at 9 West Brady Street, Tulsa, which more than triples the floor space and production capacity. All equipment is of the latest type.

Martin invented and began the manufacture of the Martin plunger and Martin rings at Tulsa in 1937, and has expanded the line to fit the hundreds of makes and sizes of pumps and well conditions. A new product, the Martin cage, employing synthetic rubber ball guides, is now in the process of manufacture.

Russell Heads New Texas Division for Hammond

Terry Russell has been appointed sales manager of the Texas Division for Hammond Iron Works. He will headquarter at the company's recently opened offices at 531 Esperson Building, Houston, covering the states of Texas, Louisiana and Oklahoma.

Russell

Russell, a graduate of the University of Texas in mechanical engineering, has been in the oil industry equipment sales business for the past 12 years, working in both California and Mid-Continent areas. He is a member of the Nomads, having made two trips to South America.

Hammond Iron Works recently opened a manufacturing plant at Port Neches, Texas, to make tankage and plate fabrication.

HERE'S A TEAM THAT CAN PULL YOU OUT OF ANY MUD HOLE

In many formations and other conditions influencing mud properties, you'll find a solution to the problem in this "team" of Cyanamid Drilling Mud Compounds:

AEROFLO* Mud Conditioning Compound is efficient in deep wells where high temperatures cause rapid thickening, in salt-cut muds and muds that resist the usual chemical treatments, and in the elimination of sand.

QUADRAFOS* (Sodium Tetraphosphate) simplifies drilling in conglomerate, sand and silty shales where the formation lacks colloidal material. It also helps control strength and gel rate caused by dispersion, heat and salt water, and renders calcium and magnesium effects inactive.

AEROTAN* Water-Loss Control Reagent is a viscous liquid supplied directly to the mud stream. It is completely soluble, requiring no heat for complete solution, and is not adversely affected by high temperatures. Excellent for treatment of cement-contaminated muds and conditions caused by bentonitic and sluffing shales and hard chert. Be sure and investigate the economies of using AEROTAN in place of the conventional types of tannins.

It's liquid

AEROSEAL Q* Mud Conditioning Compound offers an efficient and economical means of regulating mud viscosity, weight and gel strength by sealing the well walls with a thin, tight cake that promotes speed and ease of drilling under a wide variety of conditions.

**Reg. U. S. Pat. Off.*

AEROFLO, QUADRAFOS, AEROTAN and AEROSEAL Q Drilling Mud Compounds are produced under rigid chemical control. For complete information call, write or wire American Cyanamid Company, 229 Shell Building, Houston, Texas, or Los Angeles, California.

When Performance Counts—Call on Cyanamid

DRILLER DAN SAYS:

Are your mud conditions run-down, nervous, irritable? See a Cyanamid Mud Control Doctor before it's too late. He'll gladly prescribe the correct formula for recovery.

†QUADRAFOS and ‡AEROFLO are delivered from stocks kept by many drilling mud chemical distributing houses in all principal oil well drilling centers in the United States.

‡AMERICAN CYANAMID COMPANY
(Manufacturer and Selling Agent)
†RUMFORD CHEMICAL WORKS
(Manufacturer)
†AMERICAN CYANAMID COMPANY
(Selling Agent)

American Cyanamid Company

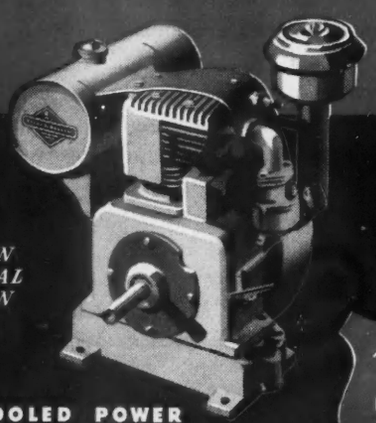
Industrial Chemicals Division

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

Now 3 1/2 Million

A NOTABLE CONTRIBUTION TO WORLD PROGRESS



Attend WISCONSIN CENTENNIAL EXPOSITION Milwaukee August 7-29

★ AIR-COOLED POWER

Preferred Power FOR INDUSTRIAL CONSTRUCTION RAILROAD AND FARM EQUIPMENT

The 3½ millionth Briggs & Stratton 4-cycle gasoline engine has recently come off the production line—headed for a job that requires *dependable* power. For 30 years these engines have met the most exacting demands on appliances and on industrial, railroad, construction, and farm equipment. The preference for Briggs & Stratton engines is a tribute to the experience and skill of the men and women who build them.

BRIGGS & STRATTON CORPORATION • MILWAUKEE 1, WISCONSIN, U. S. A.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Charles F. Kennedy Named Head Of Kennedy Valve Company

Charles F. Kennedy was elected president of Kennedy Valve Manufacturing Company, Elmira, N. Y. Kennedy has been with the company since he was graduated from the University of Michigan in 1937. He was promoted from assistant works manager to vice president and works manager in 1947. He is a grandson of the late Daniel Kennedy, who founded the business in 1877.

Charles F. Kennedy

Matthew E. Kennedy, who has been president of the company since 1928, was elected chairman of the board of directors and will also retain his position as treasurer. He has been active in the managament of the business for approximately 50 years.

Precision Jig Borer Installed At Technical Oil Tool Corporation

The Hauser Precision Jig Borer, recently installed in the plant of Technical Oil Tool Corporation, is capable of drilling holes within 40 millionths of an inch accuracy for position—so precise that a microscopic attachment must be used.

One of the very few machines of its kind in the U. S., the Hauser will also bore holes at any angle by means of a special inclinable rotary table. To keep the machine and its attachments in condition to do the precision work for which they were designed, Totco will house them in a separate temperature-controlled room.

John Rohrbach Elected President Of Raybestos Manhattan, Inc.

John F. D. Rohrbach was elected president of Raybestos-Manhattan, Inc., succeeding Sumner Simpson, who has been president since the formation of the corporation in 1929, and who now becomes chairman of the board and of the finance committee.

Rhorbach, who joined the corporation in 1939, has served in the positions of assistant to the president, executive vice president and treasurer. Previous to that time he was a senior partner in the accounting firm of J. Lee Nicholson & Company, auditors, where for many years he worked in close association with Raybestos-Manhattan in financial and advisory management capacities.

Marine Exploration Moves Into New Headquarters at Houston

Marine Exploration Company has moved into a new exploration building at 3732 Westheimer Road, Houston, which will afford the firm larger quarters and more extensive laboratory facilities.

The firm will increase their personnel, both in the administrative and technical branches. Marine has offices in Houston and New Orleans.

most Powerful in the field
ATLAS GUN!

In a remarkably short time the Atlas Gun has proven to be the most powerful gun in the field.

The Atlas Gun is only 3⅝" in diameter, and can safely be used in casings 5" O.D., whatever the grade might be. In fact, two casings are perforated as well as one casing, and this is true even if the cement is irregularly distributed.

The illustration shows a variance from approximately 1½" on one side to 6½" on the other but penetration was obtained.

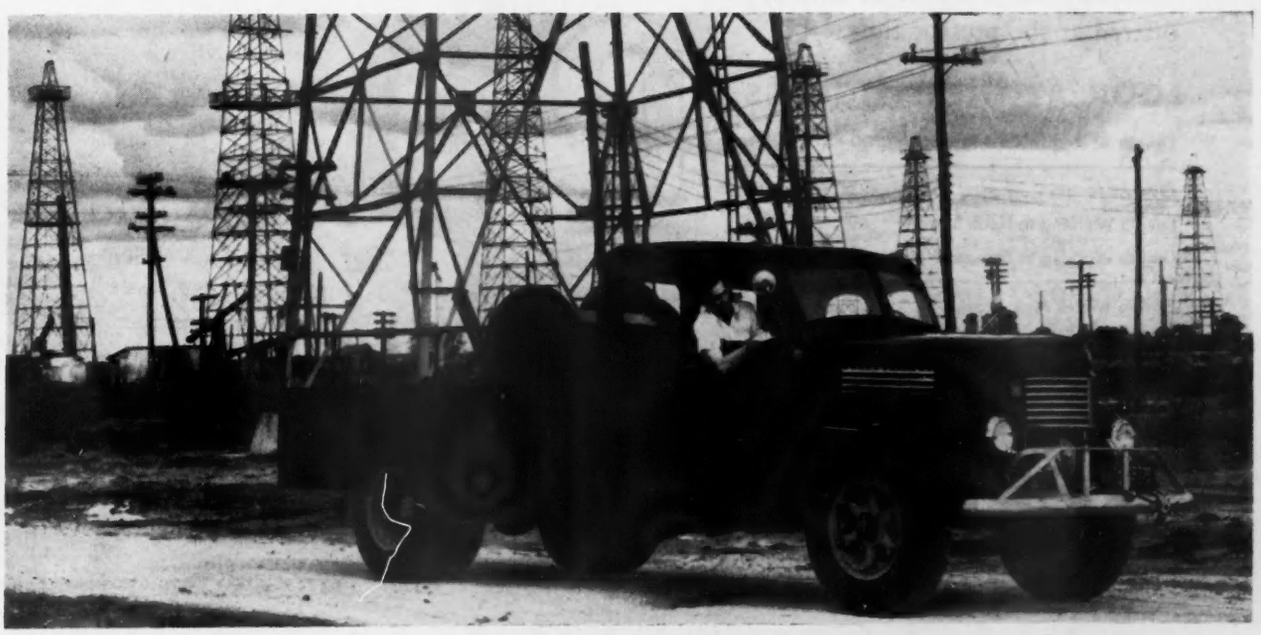
The test was under control of an oil company which supplied the cemented casings after the cement had set for 48 hours.

Only normal powder loads were used. Note the regular distribution of the shots fired selectively.

Several sections of a well can be perforated during the same trip in the hole by moving the Gun successively in front of each section and shooting up to 63 bullets per trip.

ATLAS WELL SERVICE CORPORATION

P.O. BOX 4042—HOUSTON 14, TEXAS—TEL. K. 3-5514
P.O. BOX 845—ALICE, TEXAS—TEL. 1254



I. W. Hebner Attends Three-Day Okadee Sales Meeting in Houston

I. W. Hebner, Chicago industrial manufacturing and sales executive, attended the Well Equipment Manufacturing Corporation three-day general sales meeting in Houston on Okadee Products, manufactured by one of the companies of which he is a vice president and director. Okadee Products are distributed in the greater Mid-Continent oil area by the WECO organization.

Hebner is vice president in charge of industrial, oilfield and marine sales for The Okadee Company, Chicago. He was recently made a vice president and director of the Viloco Railway Equipment Company and the Viloco Machine Company, with home offices in Chicago and the manufacturing plant in Benton Harbor, Mich.

H. G. Hagn, vice president and general manager; G. R. Winder, vice president and sales manager; and T. T. Word, Jr., assistant sales manager, of the Well Equipment Manufacturing Corporation, addressed the sales group during the meet.

ATTENTION...

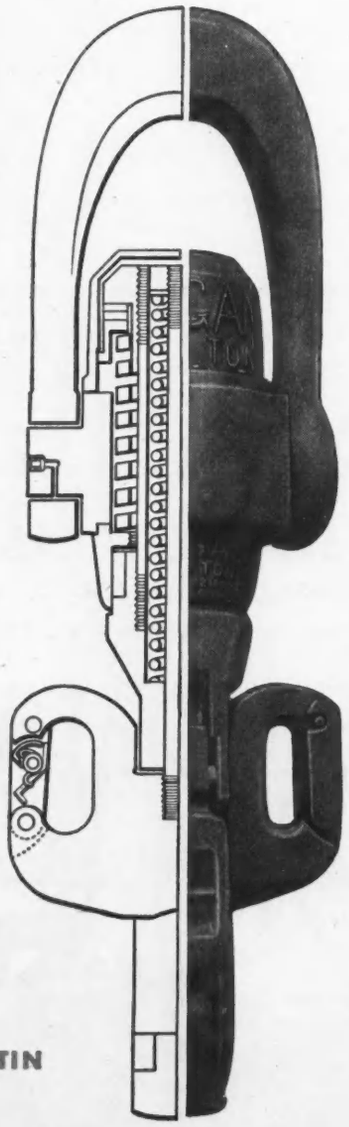
PORTABLE OPERATORS!

IF IT IS COMPACTNESS YOU REQUIRE

Because of unique telescopic action, which has been designed into the Regan 200-ton Casing Hook, Regan is able to offer a saving in overall working length of approximately

three feet

over any other hook of this type offered at the present time.



LOOK AT THESE FIGURES:

Length of Regan Casing Hook	200-ton	300-ton
Overall length	85"	101"
Length Working to Hook Saddle	69"	83"
Length Working to Elevator Yoke	56¾"	60"
Spring travel, Main Hook	2½"	2½"
Spring travel, Elevator Yoke	7½"	9½"

SEND FOR BULLETIN

Regan Forge & Engineering Co.
(Head Office), SAN PEDRO, CALIFORNIA
Bakersfield, Calif.
Houston, Texas, U.S.A.

Exclusive Mid-Continent Representatives:
Hunt Tool Company, P. O. Box 1436, Houston, Tex.

Exclusive Export Representatives:
Hunt Export Company, 19 Rector Street, New York City, N. Y.
Avda Pte. R. Saenz, Pena. 832, Buenos Aires, Argentina.

Fluid Packed Pump Company Appoints Benny Wing and Thomas B. Kennedy

Benny Wing has been appointed southern Oklahoma district representative and Thomas B. Kennedy has been named sales and service engineer for Pennsylvania and New York by the Fluid Packed Pump Company. Wing, who began work 11 years ago in the company's sales department in Louisiana, Oklahoma, and Texas, has recently been stationed at Los Nietos, Calif. Kennedy has served in various capacities from roustabout to production superintendent and for the last six years has been located in Pennsylvania oil fields.

Benny Wing

Rockwell's Assistant Treasurer Retires After Serving 46 Years

W. M. Myler, assistant treasurer of Rockwell Manufacturing Company, has retired after serving the firm 46 years. Myler was born in Allegheny in 1864 and his family moved to the East End of Pittsburgh shortly after. In 1902 he joined Pittsburgh Equitable Meter Company, which was then operated by Westinghouse in East Pittsburgh. He started as a bookkeeper and in 1907 was made assistant secretary-treasurer. When Pittsburgh Equitable Meter Company became a division of Rockwell Manufacturing Company he became assistant treasurer.

Rocky Mountain Region District Manager Appointed by Kobe, Inc.

J. C. Cooper was promoted to district manager for Kobe, Inc., in the Rocky Mountain district, where he was district representative in sole charge of operations since July, 1946. Cooper attended Texas Tech and the University of Texas. From 1936 to August, 1942, he worked for oil companies in Oklahoma and Texas. Then he went to Pearl Harbor, where he was engaged in construction for the Navy until August, 1945. He joined Kobe in September of that year as a junior engineer attached to the California Division Technical Service. In March, 1946, he was assigned to district operations in the Valley district of California, where he earned the appointment of district representative in the Rocky Mountain district of Colorado in July, 1946.

J. C. Cooper

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Failing Supply Company Sells Five Portable Drilling Rigs to Greece

Announcement has been made by the George E. Failing Supply Company of Enid, Oklahoma, of the sales of five portable drilling rigs to Greece for use in an extensive agricultural rehabilitation program for that country. These drills, which were shipped in April, will supplement a considerable amount of drilling equipment already on hand in Greece.

The program which has been outlined for Greece is one of the most extensive well-irrigation projects ever attempted in any country and calls for the development of approximately 10,000 wells. The overall program is being supervised by Dwight Griswold, former governor of Nebraska, who now is serving as head of the AMAG. The purchasing of equipment and the hiring of personnel is being supervised in this country by George McGhee, Special Assistant to the Under Secretary of State and Coordinator for Aid to Greece and Turkey.

Albert W. Braithwaite, drilling contractor with the firm of Braithwaite & Caldwell, Enid, Oklahoma, was employed by the government to help with the program. Braithwaite spent a month in Greece late last year checking over the equipment already on hand and making recommendations for the purchase of additional equipment. Since his return to this country he has been supervising the hiring of American drillers to operate the equipment which is sent over there.

Oil Center Tool Company Names South American Representatives

Oil Center Tool Company, Houston, will be represented in Venezuela, Colombia and Peru by Elmer D. Hall and J. E. (Jimmy) Berry.

Hall, who will be stationed at Puerta La Cruz, Venezuela, was formerly with the Superior Oil Company as drilling superintendent in California and Louisiana, and for some time has been connected with the Weatherford Spring Company.

J. E. Berry

E. D. Hall

Berry will be Oil Center Tool Company sales representative in Maracaibo. He has been connected with the oil industry since 1933, having worked in Texas and Louisiana and for the past ten years in Western Venezuela as driller, toolpusher and drilling superintendent for Shell Oil Company.

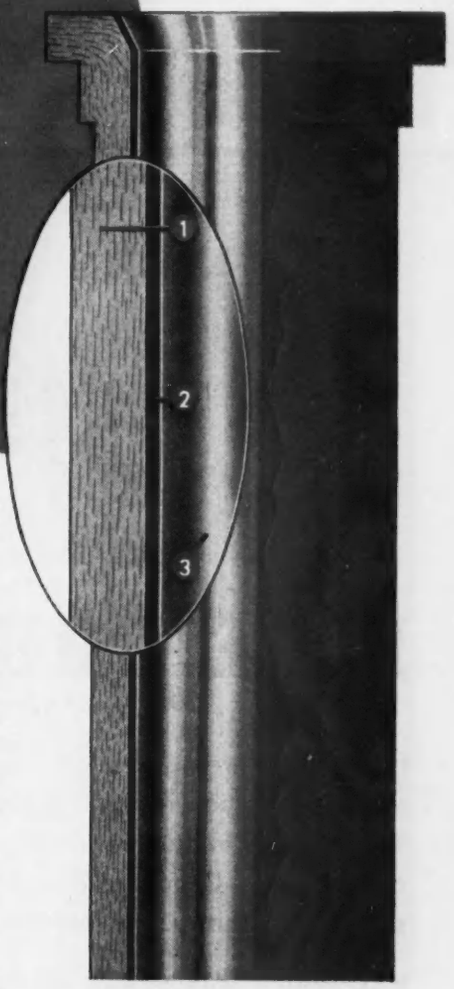
Here's why

FALCON

SLUSH PUMP LINERS

LAST LONGER!

— an achievement in metallurgy



Under the most abrasive mud conditions and highest pressures encountered in drilling, Falcon Liners are turning in record-breaking performances and long service life in the oil fields all over the world. This is no accident. It is the result of combining proper materials with sound engineering know-how.

1 CHROMIUM - MOLYBDENUM ALLOY STEEL is made into an integral forging, resulting in a fine, uniform grain structure which increases carburizing effectiveness and greatly facilitates uniformity of hardness. Also makes for a strong, tough core.

2 EXTREME HARDNESS 62-65 Rockwell "C" (approximately 700 Brinell) with a depth of penetration of .090" - .120", depending on wall thickness of liner. Careful control of hardness by heat samples and rigid inspection results in minimum distortion. Therefore, no heavy grinding into hardened surface is required to obtain a smooth straight bore, which by the Falcon process, is achieved by honing for both dimension and finish.

3 SUPER HARD MIRROR FINISH. A highly polished micro-finish which can only be produced by honing assures longer liner life against abrasion and high pressures.

Sold only through leading supply houses everywhere

FALCON PRODUCTS, INC.

POMONA, CALIFORNIA

LOS ANGELES, CALIF. 405 Subway Terminal Building • HOUSTON, TEXAS 1802 Maury Street

Branch Warehouses: ODESSA • WICHITA FALLS • OKLAHOMA CITY • JEANERETTE, LA. CASPER • RANGELY • BAKERSFIELD, VENTURA & COALINGA, CALIF. • CALGARY, CAN.

Export Representative: Guy E. Daniels, 30 Rockefeller Plaza, New York 20, N. Y.

Goodyear Appoints West Coast Tank Lining Field Engineer

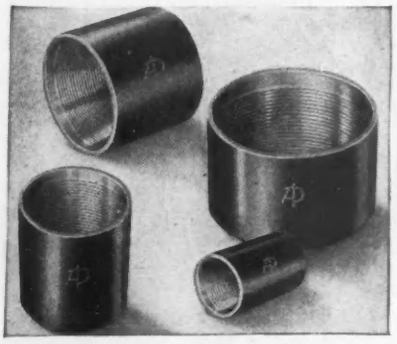
Charles A. Oostdyk, Jr., has been appointed tank lining field engineer for the west coast district of Goodyear Tire & Rubber Company's mechanical goods division.

Oostdyk will supplement the work of Goodyear engineers in Akron and Los Angeles and supervise the installation of rubber-lined equipment. His headquarters will be in Los Angeles, where he will be responsible to R. G. Abbott, Goodyear district manager.

Price Named Vice President of Operations for National Tube

Edmund G. Price has been elected vice president in charge of operations of the National Tube Company, it was announced by John E. Goble, president. He succeeds E. N. Sanders, who becomes assistant to the vice president—engineering and operations, U. S. Steel Corporation of Delaware.

Price, a native of DuBois, Penn., was employed at the Lorain, Ohio, plant of National Tube in 1924, serving in various operating positions until 1931, when he became superintendent of blast furnaces there. He was appointed general superintendent of Lorain works in 1941, serving in that capacity until 1944, when he became an executive assistant in the operating department in National Tube's general offices in Pittsburgh. He was appointed general superintendent of the company's National Works at McKeesport in 1946, where he served until his election as vice president.



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Thornhill-Craver Promotes Skeehan to Sales Manager

Jack Skeehan, Thornhill-Craver Company, Houston, Texas, has been promoted from sales representative to sales manager. Skeehan has been a member of the Unibolt sales staff since 1946, when he resigned his position with National Supply Company in Houston to accept a position with Thornhill - Craver in California.

Jack Skeehan

Skeehan's first work was with Spang-Chalfant at its Ambridge, Pa., mill. He served that company as field representative in the Southwest and did sales and engineering work in California, later being transferred to Houston to work as pipe salesman for National. During the war, he was recalled to Pittsburgh by Spang-Chalfant to serve as assistant supervisor of industrial relations, and returned to Houston for National in 1944, which position he resigned to go with Thornhill-Craver Company.

Employees of Lane-Wells Company Hold Election to Oust Union

The employees of the Lane-Wells Company recently held an election resulting in the ousting of the union from the company. The company had for the last five years a contract with the International Association of Machinists, covering the shop employees. Early this year a group of employees petitioned the National Labor Relations Board to hold an election to ascertain whether the employees wanted the union to continue to represent them. The result was 122 to 80 to oust the union.

Oil Well Supply Company Appoints C. M. Wittum as Credit Manager

C. M. Wittum, eastern division credit manager for Oil Well Supply Company since August, 1946, has been appointed credit manager for that U. S. Steel subsidiary's mid-continent and Rocky Mountain divisions. His headquarters will be at Tulsa.

W. D. Bauman, who has been with "Oilwell's" eastern division credit office at Columbus, Ohio, since 1938, was named to succeed Wittum. Bauman joined "Oilwell" in 1929 in the Credit department at Pittsburgh.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Rodney Durkee Elected President Of Western Personnel Service

Rodney S. Durkee, president of Lane Wells Company, has been elected president of Western Personnel Service, Pasadena, Calif., a non-profit research institute which supplies personnel guidance to 30 western universities and colleges. Durkee has for the past five years been vice president of the institute which furnished a link between western industry and colleges.

George H. Shetlin

L. D. Perryman

George Shetlin and L. D. Perryman Appointed by DeLaney Company

George H. Shetlin has been named sales engineer and L. D. (Slim) Perryman has been made sales representative for The DeLaney Company, manufacturers of equipment for the oil industry. Shetlin will be located in Houston and Perryman will have his headquarters in Lafayette, La.

General Electric Announces Second Reduction in Prices

Another reduction in prices of products of the General Electric Company, the second in 1948, has been announced. The reduction, a flat 5 percent, was effective April 16, and applies to certain lines of apparatus department products.

While less sweeping in application than the 3 to 10 percent reductions made by General Electric January 1, the new price cut will amount to an estimated saving of nearly $10 million annually to the company's customers.

Three Changes in Personnel Announced by S. M. Jones Firm

Holt McWorkman, formerly of Tulsa and more recently of Midland, Texas, has been appointed assistant general sales manager of the S. M. Jones Company with headquarters in the general sales office at Tulsa. McWorkman has been associated with The S. M. Jones Company for 18 years, prior to which he was employed by a major oil company in the Mid-Continent area.

C. W. Turner, formerly district representative at Wichita Falls, Texas, has been transferred to Midland as district representative. George M. Blaine, formerly sales representative in Tulsa, has been appointed district representative with headquarters at Wichita Falls.

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In competitive tests made by one major seismograph operator, Hawthorne Bits drilled 33⅓% more holes per month than conventional type drag bits. These tests, made over a six month period, are representative of favorable reports being received from many users.

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Operators report savings in bit costs over 50%. This is because the replaceable blades last longer and are much more economical than bit service on conventional type drag bits.

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One of the biggest advantages of Hawthorne Bits is that you don't have to send the bit into the shop to be serviced when blades are worn. The blades are replaced "on the drill" — on location. One bit head assembly will last for many sets of blades — many of these bit heads were in service for more than eight months using a total of 192 sets of blades before the bit assembly itself had to be replaced.
This "on the drill" bit service is especially advantageous to foreign operators where repair shops are few and far between.

● ALL FORMATION DRILLING

Hawthorne Replaceable Blade "Rock Cutter" Bits have proved capable of drilling more hole in soft formations in less time than any conventional type drag bit. Furthermore, these blades successfully drill broken formations and many rock formations that have previously required roller bits. This means faster drilling, fewer round trips to change bits and lower bit costs.
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500 Attend Opening of Republic Supply Company Store

More than 500 oil men and oil equipment people, representing all phases of the industry, attended the opening of Republic Supply Company's store in Lake Charles, La., the newest of the 51 stores of the Republic Supply Company, which was recently sold by Republic Steel Corporation to a group of private investors.

The Lake Charles store is a one-story structure of medern design with separate sales offices and display quarters. It is completely stocked with supplies for the oil industry.

New owners of this and other Republic Supply stores are Robert S. Kerr, former governor of Oklahoma, and D. A. McGee and Associates of Oklahoma City. The latter interest owns the Murray Tool & Supply Company, which has stores in Oklahoma City, Elmore City and Pawhuska, Okla., as well as a manufacturing plant at Pawhuska. These Murray stores will be added to Republic's sales and service points.

Except for the specialties produced by Murray Tool & Supply Company's manufacturing plant, Republic manufactures no products of its own but serves as a supply outlet for the products of more than 200 leading manufacturers.

Executive vice president is Don Collins, president of Murray Tool & Supply Company, who will also move to Houston. H. B. Catlow is vice president and manager of sales, and John H. Lollar, Jr., is secretary and treasurer.

The company's new central warehouse and store is in Houston, which occupies a site of 13 acres and has more than 100,000 square feet of display and storage space. It is a general supply depot for the company's numerous stores, in addition to serving the Houston territory.

Main offices are in Houston, where A. B. Judd, president, has his headquarters. Judd was vice president and general manager of Republic Supply Company before its sale.

Baker Oil Tool Employes Vote Not to Affiliate With Union

Employes of Baker Oil Tool Company, Houston, voted late in April not to affiliate with any union for bargaining purposes. The election, held on the proposition of the employes being represented by the International Association of Machinists (IMD) or no union, voted 40 to 14 in favor of no union representation.

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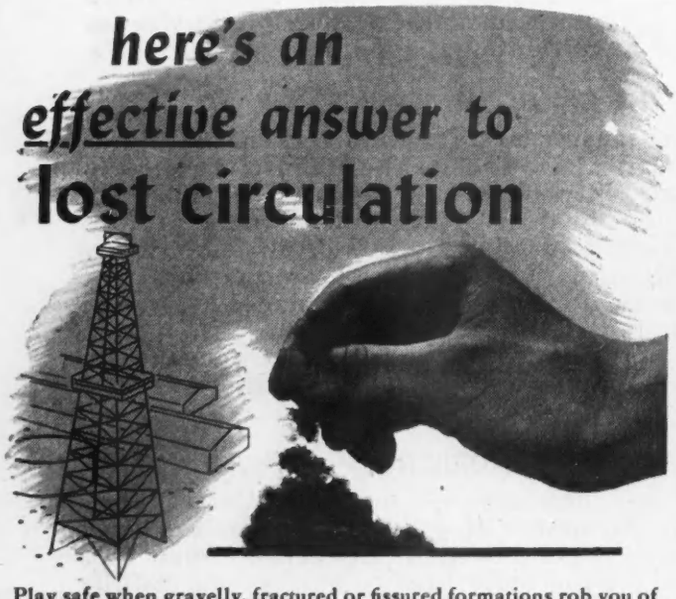

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New Books

Central Colorado Geology

"Guide to the Geology of Central Colorado," Vol. 43, No. 2 of the Quarterly of the Colorado School of Mines, was published as the guidebook for the three field trips of the 33rd annual meeting of the American Association of Petroleum Geologists at Denver in April.

The publication comprises 176 pages, including 38 figures. In addition, there are 14 plates, including one 24-by-28-inch index map of Colorado, showing major geologic structure and significant oil and gas information.

In addition to discussions of principal features of the areas in which the field trips are made, and road logs for the trips, there are authoritative articles on the geology of the eastern flank of the Front Range of Colorado; the Kokomo, Gilman, and Leadville mining districts; the Climax molybdenite deposit; the oil-shale deposits in the vicinity of the naval oil-shale reserve, Garfield county; the oil-shale demonstration plant at Rifle; and the geology of South Park.

Department of Publications, Colorado School of Mines, Golden, Colo., $3, postpaid.

Alluvial Plain

Years of research were spent in obtaining the information in Bulletin 65, published in cooperation with the Mississippi State Geological Survey. This voluminous report covers the Alluvial Plain, the so-called delta of a 6600 square mile empire of rich soil, rich subsoil, and rich alluvium nearly 150 feet in average thickness. This area had to be investigated chiefly through a study of water and oil prospect well logs and samples, and should prove to be a storehouse of information to the driller. Much of the information contained in the report is being published for the first time.

This 424-page report has many folding maps and charts and an abundance of tables.

Mississippi State Geological Survey, University, Mississippi.

Engine Test Methods

The ASTM "Manual of Engine Test Methods for Rating Fuels" covers in concise form the five engine test methods that are commonly used throughout the petroleum and automotive industries. In addition, there are six supplements which thoroughly cover the design of laboratory facilities and equipment, the availability and supply of materials and apparatus, and the operation and maintenance of equipment.

The manual has been designed and compiled with a view to making it useful as a reference work for executives and supervisors, as a guide in the training of operators and technicians, and as a reference manual for the people who test fuels and maintain equipment.

ASTM Headquarters, 1916 Race Street, Philadelphia 3, Penn. Price, $8 each, with reduced prices on orders in quantity.

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